that from KCl to mercury when the tension of the surface separating the solution from the mercury is a maximum.

These results follow from direct observations with dropping electrodes, and give further support to the view that the first assumption of the Lippmann-Helmholtz theory is true and that the second is not.

"The Influence of Removal of the Large Intestine and Increasing Quantities of Fat in the Diet on General Metabolism in Dogs." By VAUGHAN HARLEY, M.D., Professor of Pathological Chemistry, University College, London. Communicated by Professor VICTOR HORSLEY, F.R.S. Received July 25,—Read November 17, 1898.*

CONTENTS.

1. Introduction.
2. The composition of the excretion of a loop of the large intestine.
3. The operation, diet, and analytical methods employed.
4. The influence of the removal of the large intestine on the absorption of carbohydrates.
5. The influence of diet on the urine and the normal absorption of proteid and fat, together with its influence when the large intestine is partially or entirely removed.
6. The effects of the diet on the total solids of the fæces.
7. The daily quantity of the water and the percentage of the water in the fæces in normal dogs and after partial or complete removal of the large intestine.
8. The breaking up of fat in the alimentary canal in normal dogs, and after partial or complete removal of the large intestine.
9. The action of the removal of the large intestine on the urobilin formation in the fæces.
10. The influence of diet on the total alkaline and aromatic sulphates in normal dogs and in those in which the large intestine has been in part or completely removed.
11. Summary.

Introduction.

When I commenced my investigations into the functions of the large intestine by means of experimenting with isolated loops, into which milk was injected, and after some hours again collected, I found that the analysis yielded most unsatisfactory results. In consequence, in order to get over the difficulty, it seemed better to try the effect of the removal of the large intestine on nutrition. I believed that by comparing the analysis of the urine and fæces of dogs after removal of the large intestine with that of normal dogs on precisely similar diet, the effect of the absence of the large intestine would be sufficiently clearly demonstrated, and by this means its functions would be better understood.

* Received during recess and published in abstract in this volume at p. 77 *supra*.

In the earlier method of experimenting with loops of the large intestine, in some experiments the middle part of the large intestine was isolated, forming a Vella's fistula.

A given quantity of food was passed into the fistula, and after some hours it was again collected for analysis. By this means, however, I found it impossible to collect the entire quantity put into the fistula unless very large quantities of wash-water were used, which rendered the analysis fallacious. I do not therefore refer in this paper to the results thus obtained, but at the same time wish to draw attention to the fact that in these dogs the Vella's fistula was found in the intervals between experiments to fill up with *débris*. For example, in one case the middle (17 cm.) of the large intestine was separated, the upper and lower ends being sewn to the abdominal wound; the upper and lower part of the divided remnant of the intestine was connected together. The dog at first was fed on milk and gradually on a better diet, as, indeed, all the animals about to be described were treated. The operation was done in this case in March, 1894, and by May, after careful feeding, the dog had gained three pounds in weight, so that the absence of the large intestine had not hindered the animal from putting on flesh.

The Composition of the Excretion of a Loop of the Large Intestine.

In May the material that had collected in the loop was analysed, and again on another occasion in December of the next year when the dog was killed. The following are the results of these analyses:—

Analysis of *débris* collecting in loop of large intestine of dog.

	Qt.	Solids.	Water.	N.	Fat and cholesterin.	Ash.
	grams.	p. c.	p. c.	p. c.	p. c.	p. c.
May, 1894 ...	4·000	36·596	68·804	...	2·473	0·965
Dec., 1895 ...	3·2107	33·501	66·499	3·644	2·171	...

The analyses above given correspond very closely to those which have been found to occur in loops of the small intestine.

Hermann,* Ehrenthal,† Berenstein,‡ and Fr. Voit,§ in their examination of isolated loops of the small intestine, showed that they were apt to fill up with contents, which, microscopically and chemically, corresponded with the materials collected from the loop of large intestine in the above dog.

* L. Hermann, 'Pflüger's Archiv,' vol. 46, p. 93, 1890.
† W. Ehrenthal, *ibid.*, vol. 48, p. 74, 1891.
‡ M. Berenstein, *ibid.*, vol. 53, p. 52, 1892.
§ Fr. Voit, 'Zeit. f. Biol.,' vol. 29, p. 325, 1892.

In Voit's analysis the contents of the loop of the small intestine contained fat, nitrogen, and salts in a proportion very much corresponding to that found in the above dog, and he, together with others, considers this a normal excretion from the small intestine which goes in great part to form the fæces on a diet which is well absorbed.* The above result obtained in the large intestine is of importance, as it shows that a similar excretion occurs in the large intestine, as that already known to occur in the case of the small intestine, and this observation will explain in all probability the results obtained as regards cholesterin when the large intestine was removed (*vide* page 287).

With these preliminary remarks we can now turn to consider the present research, and before doing so, it is as well to describe briefly the operative procedure which was carried out.

Operative Procedure.

The dog, after being put under an anæsthetic, had its large intestine thoroughly washed out by means of an enema, and after abdominal section the bowel was divided just above the cæcum, and also as low down and as near the anus as possible. The lower part of the small intestine was then stitched into the rectum, care being taken to pre-

* v. Moraczewski has since the writing of the present article published a paper on contents of occluded portions of the intestine. His experiments are limited, however, to two dogs, in both of which cases after the loop had been isolated the animals were allowed to live for about a year, being well fed throughout.

In the first dog the loop consisted of part of the ilium, cæcum, and the commencement of the colon. The material collected at the end of a year from this loop was coloured, and the analysis was roughly as follows :—

Qt.	Solids.	Water.	Proteid.	Fat and cholesterin.	Ash.
grams.	p. c.	p. c.	p. c.	p. c.	p. c.
360	26	74	1	43	20

In the second dog only part of the ascending colon was isolated, so that we should here get the excretion from the large intestine, not contaminated by anything from the small. The contents in this case were colourless. Unfortunately the absolute quantity of analysis is not stated. However, he says it contained very little proteid or fat, and no cholesterin or lecithin, but principally only sodium carbonate.

From these results Moraczewski concludes that the secretion, or rather, as I should prefer, the excretion, from the different parts of the intestine differs, that from the small intestine containing colouring matter, fat, and cholesterin, while that from the large intestine is only sodium carbonate.

My own analysis of the contents of the large intestine, although naturally the quantity of material used was not so great and the period of collection much shorter, does not lead me to entirely agree with the above results. The fat was distinctly less than the quantity found in the small intestine of Moraczewski, but both fat and nitrogen were undoubtedly present, and the ash was extremely small ('Zeit. f. Physiol. Chem.,' 1898, vol. 25, p. 122).

serve a good blood supply, and as far as possible not to allow too much tension at the place of juncture, as otherwise the ligatures were apt to give way, and to be followed by a fatal peritonitis. The isolated portion of the large intestine, together with the cæcum, was in some cases merely closed at both ends so as to form a kind of Hermann's loop. It was found, however, that this was not satisfactory, for no amount of washing out the loop would remove all the bacteria therein contained, and the loop tended to fill with the normal excretion already described, and this, together with the bacteria present, led to rupture and fatal peritonitis. The loop was sometimes found to fill with a very watery fluid, so that in one case it was found distended with a dirty brown fluid even in spite of a slight rupture having already occurred. It was therefore decided that it would be more satisfactory to entirely remove the isolated portion of the large intestine.

Of the experiments about to be described in one case the large intestine was only partly removed—that is to say, slightly more than its middle third. In the other two dogs the large intestine was entirely removed together with the cæcum.

The dogs after the operation were then put on milk diet and the quantity was gradually increased with the addition of beef-tea and meat, until ordinary diet was able to be given; and the experiments on the metabolism were only carried out on dogs which had been on ordinary diet for some time, and had regained practically their normal weight.

The Diet Employed.

As far as the food used during the experiments, it was found most convenient to sterilise weighed out portions of minced meat, each quantity being sufficient for the day, and to this was added the given quantity of biscuit and fat as required. In all cases each meat, biscuit, or fat had been previously analysed, three separate samples being employed for the purpose, and the average of the three analyses were taken in calculating the nitrogen and fat of the diet.

The Methods of Analysis.

With regard to the method of analysis employed, and collection of material for analysis, the urine was collected by means of a catheter; at the same time the animals were kept in a cage, in case by any accident they should pass water by day or night, that also would be collected in the cage and added to that obtained by the catheter. As a matter of fact, dogs sufficiently often catheterised pass very little into the cage direct. The fæces were collected into the cage itself.

The nitrogen in the urine and fæces was in both cases analysed by

the method of Kjeldahl, and the sulphates after the method of Baumann.

As far as the fæces were concerned, in all cases they were examined with the ordinary precautions necessary in metabolism experiments, each daily quantity being separately examined, and the periods separated by means of charcoal. They were dried down over a water-bath, after adding dilute sulphuric acid, so as to avoid any escape of ammonia in the drying process. The drying was continued in a drying cupboard until they became a constant weight, and from this the quantity of water and solids was calculated. The dried residue was analysed for nitrogen and fat after the usual methods. Naturally in those cases where the fats were separately analysed, the portion of fæces taken for the analysis was not dried down with the sulphuric acid, but, on the other hand, extracted with alcohol, the alcohol extract being evaporated over a water-bath, and the total extracted with ether, and the fats, cholesterin, &c., separated, as I have already described in a former paper.*

As regards the carbohydrates, it was originally intended to estimate the quantity in all the experiments, but it was found in one normal dog, and in one dog in which the large intestine had been entirely removed, that of the carbohydrates given in a diet of biscuit and meat there was neither loss in the fæces in the normal, nor in the case of the complete absence of the large intestine; it was therefore considered unnecessary to repeat these experiments.

In order to investigate the effect of the removal of the large intestine on the general metabolism, it was necessary to examine in close detail the normal conditions of dogs fed on, roughly speaking, the same diet.

The Influence of Increasing Quantities of Fat in the Diet on the Metabolism of Normal Dogs.

For this purpose the quantity of proteid and carbohydrate throughout each research was kept constant, only the quantity of fat being increased during different periods, and the same experiments being repeated on dogs with either the partial or complete removal of the large intestine. In calculating the quantity of proteid or fat absorbed from the alimentary canal, no allowance is made for the quantity of nitrogen which is normally present in the fæces in a fasting animal.

C. Voit and Fr. Müller† have shown that even during fasting there is an elimination of fæces. For example, in a dog of 30 kilos. the average was about 2 grams of dried fæces daily, containing no less than 0·15 gram of nitrogen.

* Vaughan Harley, 'Roy. Soc. Proc.,' vol. 61, 1897.

† Fr. Müller, 'Zeit. f. Biol.,' vol. 20, p. 343, 1884.

Rieder* found that on feeding dogs with a nitrogen-free diet the fæces contained absolutely more nitrogen than during fasting, and often than that obtained on a pure meat diet. A dog on 500 grams of starch-meal gave 0·7 gram, with 700 grams of starch-meal it gave 0·8 gram of nitrogen in the fæces; while with 1500 grams of meat the fæces only contained 0·67 gram of nitrogen.

J. Tsuboi† has lately carried out the same researches with the greater accuracy of modern methods in Professor Voit's laboratory, and his results show that the nitrogen of the fæces on an absolutely nitrogen-free diet is greater than that during fasting, and the quantity of nitrogen increases with the quantity of food. In fact, the quantity of nitrogen in the fæces on a nitrogen-free diet may be as much as that found on the diet of meat rich in nitrogen.

It is thus seen that on such a diet the greater quantity of the nitrogen of the fæces must be regarded not as a nitrogen residue, but as the product of metabolism.

It has already been stated that the contents of the Hermann's loop are probably to be regarded as consisting of such metabolic products; and, as I have already shown in this paper, the large intestine behaves in exactly similar manner. Although by calculations on animals and man, one has a rough idea of the daily quantity of nitrogen and fat that ought to be eliminated during fasting, and although one can subtract that amount from the quantity found in the fæces, in the case where the large intestine was removed this could not be done, as we have no data showing the daily quantity of nitrogen or fat that is eliminated by the large intestine. It was therefore considered better in calculating absorption of proteids and fat, to neglect from the estimation the quantities probably excreted in fasting.

We will now consider the experimental details, and in the first instance I will refer to two normal dogs, which are taken for the purpose of comparison with those in which the large intestine was removed, and in which the quantity of fat ingested during various periods was steadily increased. These details are given in the following table (p. 261).

Dog 1.—In the preceding Table I we see the influence of the addition of fat to the diet on the absorption and metabolism in a normal dog.

In this table the sterilised meat was commenced eight days previous to the first analysis, the animal being on nitrogen equilibrium. The diet consisted of sterilised beef, biscuit, and small quantities of fat; water was given twice a day, and the dog was allowed to drink as much as she pleased each time.

(*a*) During the first period of four days the quantity of nitrogen in

* Rieder, *ibid.*, vol. 20, p. 382, 1884.

† J. Tsuboi, *ibid.*, vol. 35, p. 76, 1897.

Table I.

Dog 1.—The Influence of an Increasing Quantity of Fat to a Staple Proteid and Carbohydrate Diet on the general Metabolism and Absorption. Diet consisted of 100 grams of Sterilised Beef and 60 grams of Biscuits.

Day.	Weight.	Diet, total.		Urine.			Fæces.			Absorbed.	
		N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
(*a*) 8th....	4·59	4·82	12·04	125	1050	4·382	17·79	0·274	..	94·31	..
9th....	4·59	4·82	12·04	130	1062	4·810	18·65	0·299	0·710	93·79	94·10
10th....	4·59	4·82	12·04	120	1060	4·399	18·50	0·338	0·711	92·98	94·10
11th....	4·59	4·82	12·04	95	1058	4·236	19·51	0·494	0·778	89·75	93·54
Average ...	4·59	4·82	12·04	118	1058	4·236	18·61	0·351	0·733	92·71	93·91
(*b*) 15th....	4·59	4·82	32·04	95	1054	3·754	24·67	0·497	1·330	89·68	95·85
16th....	4·59	4·82	32·04	94	1054	3·625	20·53	0·439	1·141	90·89	96·44
17th....	4·59	4·82	32·04	80	1065	3·164	18·95	0·351	0·673	92·71	97·90
18th....	4·59	4·82	32·04	85	1067	3·755	17·52	0·359	0·741	92·55	97·72
Average....	4·59	4·82	32·04	89	1060	3·575	20·42	0·412	0·971	91·45	96·97
(*c*) 22nd ...	4·63	4·82	62·04	70	1060	3·235	19·62	0·393	0·876	91·84	98·59
23rd....	4·63	4·82	62·04	65	1065	3·340	28·26	0·620	1·583	87·13	97·45
24th....	4·63	4·82	62·04	60	1060	3·085	17·52	0·364	0·951	92·44	98·46
25th....	4·63	4·82	62·04	85	1057	3·789	25·41	0·500	1·644	89·62	97·35
Average....	4·63	4·82	62·04	70	1060	3·362	22·70	0·469	1·264	90·26	97·96

the urine remained almost constant; it rose somewhat on the ninth day, when a little more urine than usual was passed of a higher specific gravity. The average quantities are better discussed later on.

The fæces for the first two days contained rather less nitrogen than the next two, so that the percentage absorbed during the different days varied from 89·75 per cent. to 94·31 per cent. of the total nitrogen, as estimated by subtracting the quantity of nitrogen left in the fæces from the quantity known to be given in the diet. The fat in the diet was in this case 12·04 grams, and the fæces contained during three days from 0·710 to 0·773 gram, one day being unfortunately lost, so that the percentage absorption of fat fluctuated from 94·54 to 94·10.

(*b*) The diet on the twelfth day increased, so that the dog received 32·04 grams of fat, and charcoal was given on the fifteenth, and another period of four days analysed. During the four days the urine remained pretty well constant, being from 95 to 80 c.c. The nitrogen on the fifteenth, sixteenth, and eighteenth days was almost the same, 3·754 grams, but the seventeenth day it fell somewhat to 3·164 grams.

The quantity of fæces varied from 17·52 to 24·56 grams, and the nitrogen also varied, the daily quantity fluctuating between 0·351 and 0·497 gram, the fat showing again a greater fluctuation from 0·673 to 1·330 grams.

Thus the percentage absorption of proteids varied between a range of 89·68 and 92·71 per cent., while the fat varied between 95·85 and 97·90 per cent.

On the 19th another 30 grams of fat was added to the diet, so that the dog now received no less than 62·04 grams of fat per diem, as well as the original quantity of proteids and carbohydrates.

(*c*) On the 22nd the analyses were again begun, and carried on for four days. The quantity of urine varies from 60 to 85 c.c.; the specific gravity shows the same fluctuation.

The nitrogen in the urine had its lowest limit at 3·085 grams; its highest at 3·789 grams. The quantity of fæces varied from day to day between 17·52 and 28·26 grams, and there was a very marked difference in the quantity of nitrogen eliminated in the fæces during the eight days, being on one day as low as 0·364, while another day it reached as high as 0·620 gram.

The fat in the fæces varied from 0·876 to 1·644 grams per diem. This different quantity of nitrogen and fat on the different days caused the percentage of the nitrogen absorbed to vary from 87·13 to 92·44 per cent., while the percentage of fats varied from 97·35 to 98·59 per cent.

Dog 2.—In Table II, which gives the details of Experiment 2, there were two separate periods in which the quantity of fat given remained the same, the diet containing 8·00 grams of nitrogen and 15·20 grams of fat.

Table II.

Dog 2.—The Influence of an Increased Quantity of Fat to a Diet containing a Fixed Quantity of Proteid and Carbohydrate. The Diet consisting of 150 grams of Sterilised Beef and 100 grams of Biscuit.

Day.	Weight.	Diet, total.		Urine.			Fæces.			Absorbed.	
		N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
(*a*) 9th ..	6·41	8·00	15·20	130	1050	6·950	22·70	0·414	0·458	94·82	96·99
10th ..	6·41	8·00	15·20	130	1055	..	27·45	0·597	0·661	92·53	95·65
11th	6·41	8·00	15·20	100	1060	5·972	25·93	0·552	0·632	93·10	95·84
12th	6·41	8·00	15·20	115	1052	5·460	50·59	1·223	1·353	84·70	91·10
Average ..	6·41	8·00	15·20	119	1054	6·127	31·67	0·696	0·776	91·29	94·68
(*b*) 14th ..	6·41	8·00	15·20	90	1062	5·330	33·30	0·739	0·831	90·76	94·53
15th ..	6 41	8·00	15·20	85	1063	5·159	17·53	0·504	0·539	93·70	96·45
16th ..	6·41	8·00	15·20	115	1060	6·314	40·45	0·954	1·139	88·07	92·51
17th ..	6·40	8·00	15·20	143	1050	6·258	43·20	0·999	1·084	87·50	92·87
Average ..	6·41	8·00	15·20	108	1059	5·815	33·62	0·799	0·898	90·01	94·09
(*c*) 21st ..	6·47	8·00	65·19	93	1060	4·190	29·36	0·717	1·792	91·03	97·25
22nd ..	6·52	8·00	65·19	50	1062	3·115	34·41	0·830	2·074	89·62	96·82
23rd ..	6·63	8·00	65·19	80	1058	4·270	39·17	1·067	2·666	85·65	95·91
24th ..	6·75	8·00	65·19	..	..	..	42·09	0·988	2·466	87·64	96·22
Average ..	6·59	8·00	65·19	74	1061	3·858	36·26	0·901	2·249	88·73	96·55

(*a*) During the first four days the quantity of urine was rather high, from 100 to 130 c.c.; the nitrogen varied from 5·460 to 6·950 grams.

The fæces varied in the different days from 22·70 to 50·59 grams. It was indeed in consequence of a great increase of fæces on the twelfth day that it was thought advisable to give the dog another period of four days on the same diet.

The nitrogen varied, as one would expect, with the quantity of fæces, fluctuating from 0·414 to 1·223 grams, and the fat from 0·458 to 1·353 grams.

In this case the quantity of nitrogen, fat, and the daily quantity of fæces were separately analysed, so that the great rise on the twelfth day in both nitrogen and fat found eliminated in the fæces, was not due to an error of drying, but to the quantity absolutely found by analysis on that day.

(*b*) During the next period of four days, for some unexplained reason, the quantity of urine passed during the fourteenth and fifteenth days was markedly diminished, being only 90 and 85 c.c., while on the sixteenth and seventeenth it rose to 115 and 143 c.c. In spite of this variance in quantity the averages of the two periods, as will be later seen, are well within reasonable limits.

The nitrogen in the urine was, as one expected, increased during the sixteenth and seventeenth days, being no less than 6·314 and 6·258 gram, as against 5·159 and 5·530 grams on the fourteenth and fifteenth days, when the quantity of urine was low.

As far as the quantity of fæces was concerned, on the fourteenth day 33·30 grams were passed, while on the fifteenth day it dropped to only 17·53 grams; on the next days 40·45 to 43·10 grams were passed.

The quantity of nitrogen in the fæces varied from 0·504 to 0·999 gram, and the fat from 0·539 to 1·139, so that the absorption of nitrogen varied from 87·50 to 93·70 per cent., while the absorption of fat varied from 92·51 to 94·53 per cent.

On the eighteenth day the fat in the diet was increased to 65·19 grams, and the analysis commenced on the twenty-first day.

(*c*) During the three days on which it was analysed the quantity varied between 50 and 93 c.c., and the quantity of nitrogen from 3·115 to 4·270 grams.

In this stage of the experiment the quantity of fæces varied from 29·36 to 42·09 grams on the last day, and the nitrogen in the fæces being for the first day only 0·717, while on the twenty-third day it reached no less than 1·067 grams.

The fat was naturally very much increased by this large increase in the diet, being 1·792 grams on the twenty-first day, and on the twenty-third day 2·666 grams. The percentage of proteids, as indicated in

the fæces, varies on different days from 86·65 to 91·03, while the fat varies from 95·91 to 97·25.

It will be well to now compare the averages of the two preceding normal dogs before we discuss what occurs after the removal of the large intestine.

The normal averages are given in Table III.

Dog 1.—Table III during the three periods of the experiment (*a*), (*b*), (*c*) received the same quantity of nitrogen, 4·82 grams. During the period (*a*), 12·04 grams of fat were given; during period (*b*), 32·04 grams, and during period (*c*), 62·04 grams. As far as the weight was concerned, the increase of fat from 32 grams caused no real increase in the average weight. The further increase to 62 grams of fat caused an increase of weight from 4·59 to 4·63 kilos.

So far as the quantity of urine is concerned, the interesting fact is brought out that the increase of fat in the diet caused a progressive decrease in the quantity of urine from 118 to 89 c.c., and 70 c.c. respectively, and this corresponds with an increase of specific gravity in the different periods. The fat also caused a decrease of the quantity of nitrogen eliminated in the urine, the quantity falling from 4·457 to 3·575 grams, on increasing the fat from 12 to 32 grams, and still further to 3·362 grams, by increasing the fat ingested to 62 grams. The marked difference in the fall of nitrogen excreted during (*a*) and (*b*), when the fat was increased 20 grams, is due to the animal having been on rather a small quantity of nitrogen, although on nitrogen equilibrium. On the other hand, when later on the fat ingested was increased to 62 grams, there was but a small decrease in the elimination of nitrogen, because the animal was, comparatively speaking, fat. The quantity of fæces steadily increased as the fat was increased in the diet, rising from 18·61 to 20·42 and 22·70 grams during the periods (*a*), (*b*), (*c*).

The nitrogen in the fæces also steadily increased with the increase of fat in the diet. Thus, on the relatively poor fat diet, 0·351 gram of nitrogen was eliminated; but, on increasing the fat in the diet in spite of the fat containing no nitrogen, there was an increase in the quantity of nitrogen in the fæces to 0·412 gram, which still further increased to 0·469 gram when the fat in the diet was increased to 62·04 grams.

The fat in the fæces also increased from 0·733 to 0·971 gram, and to 1·264 grams as the fat was increased in the diet.

That the increase of fat in the diet should cause a decrease of nitrogen in the *urine* is what one naturally expects,* but that the increase in the fat ingested should cause an increase of nitrogen in the fæces is not what might have been *à priori* expected to occur. That

* A. Pugliese, 'Du Bois-Reymond's Archiv,' 1897, p. 473, shows that increasing the fat in a fixed diet causes a decrease in the nitrogen eliminated in the urine.

Table III.—Average of two Normal Dogs, on a Diet containing an Increasing Quantity of Fat.

No. of experiment.	Weight.	Duration of observation.	Diet.		Urine.			Fæces.			Absorbed.	
			N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	days.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
1 (*a*)	4·59	4	4·82	12·04	118	1058	4·457	18·61	0·351	0·733	92·71	93·91
(*b*)	4·59	4	4·82	32·04	89	1060	3·575	20·42	0·412	0·971	91·45	96·97
(*c*)	4·63	4	4·82	62·04	70	1060	3·362	22·70	0·469	1·264	90·26	97·96
2 (*a*)	6·41	4	8·00	15·20	119	1054	6·127	32·67	0·696	0·776	91·29	94·68
(*b*)	6·41	4	8·00	15·20	108	1059	5·815	33·62	0·799	0·898	90·01	94·09
(*c*)	6·59	4	8·00	65·19	74	1061	3·858	36·26	0·901	2·249	88·73	96·55

this is due to an increased excretion or secretion from the intestines seems unquestionable, as already suggested by Voit, Müller, &c.

When we turn to the question of absorption, we find that so far as the nitrogen is concerned an increase of fat causes a decrease in the percentage of absorption, while, as in period (*a*), with 12·04 grams of fat, 92·71 per cent. of the nitrogen was absorbed; on increasing the fat to 32·04 grams, 91·45 per cent. was absorbed; and on still further increasing it to 62·04 grams, 90·26 per cent. was absorbed.

The fat absorption, on the other hand, instead of decreasing with the increase of fat in the fæces, really increased, so that it would appear as if there was a greater absorption of fat on a diet rich in fat than on one poor in fat.

In period (*a*) only 93·91 per cent. of the total fat given was absorbed, as compared with 96·97 in (*b*) and 97·96 per cent. in (*c*). This apparent increased percentage of absorption of fat must be attributed to the quantity of fatty matter excreted normally from the intestine, so that when the fat in the diet is small this quantity alone is sufficient to alter the apparent percentage very markedly. On the other hand, when the quantity of fat in the diet is large the small quantity excreted by the intestines makes little difference in the quantity in the fæces, so that the percentage absorbed appears to be higher than what is really the case.

Continuing the discussion of the normal averages, we now come to dog 2 (*vide* Table III).

In the first two periods (*a*) and (*b*) the diet was exactly the same, the reason being that the individual days fluctuated so much that it was thought better to do two periods for a normal standard.

It is seen the quantity of urine was 119 and 108 c.c. per diem during the two periods (*a*) and (*b*). The same may be said of the nitrogen in the urine, which was 6·127 and 5·815 grams; the parallelism of the two periods is therefore close.

The fæces amounted to 31·67 and 33·62 grams, and the quantity of nitrogen in the fæces during these two periods was 0·696 and 0·799 gram, while the fat was 0·776 and 0·898 gram respectively.

The percentage of absorption of the proteids was 91·29 and 90·01 per cent., while the absorption of fat was 94·68 and 94·09 per cent.

On increasing the fat to 65·19 grams the animal increased in weight. The quantity of urine fell to only 74 c.c., while the specific gravity rose to 1061. The total quantity of nitrogen in the urine fell very markedly to 3·858 grams; the quantity of fæces rose to 36·26 grams, and contained 0·901 gram of nitrogen, so that the quantity of fæces and nitrogen had increased on increasing the fat in the diet in the same manner as in the case of the preceding dog.

The fat in the fæces increased to no less than 2·249 grams. In this case 88·73 per cent. of the nitrogen and 96·55 per cent. of the fat was

absorbed. Thus in this dog we have exactly the same results as in the preceding dog, and therefore we can take these two normal dogs as a standard for comparison with the results obtained after the removal of the large intestine.*

The Influence of Partial Removal of the Large Intestine on Metabolism.

We now come to consider the effect of removal of the large intestine on general metabolism under similar circumstances to what we have found in normal dogs on increasing the amount of fat contained in their diet. Before doing so, however, we will consider by way of preface a case of partial removal of the large intestine.

In this experiment the middle third of the large intestine was converted into a Vella's fistula, the cæcum being attached to the rectum, on March 20, 1894, at which time the dog (a female) weighed 12 lbs. In December of that year her weight had risen up to 15 lbs., and the experiments about to be described were not carried out till November, 1895.

During a part of the time, before the experiments were completed, the dog was fed up, and became so fat at one time as to be practically unable to walk down stairs. It was from the results which were then obtained in this case of the partial removal of the large intestine that the present research was entered into, although the original experiments had been intended to be an investigation into the absorption from the large intestine, using fistulæ for that purpose. The post mortem examination showed the fistulous part of the large intestine, which was over 17 cm. long, to be very much narrower than normal, and to contain *débris*, mostly impacted, in the region of the fistula. This was analysed as already stated.

In this case, from the ileo-cæcal valve to the sutured junction, the

* Wicke and Weiske, in some experiments on the influence of the addition of fats and starch to the diet on metabolism, experimented with sheep. These two observers found that increasing the quantity of fat in the diet caused an increasing quantity of fæces to be eliminated. At the same time, less nitrogen was excreted in the urine, so that the fat acted as a nitrogen sparer to the organism.

It is thus seen that these experiments, in which fat was added to the diet of herbivora, yielded the same results as are found in the above tables in the case of the carnivora, except in one small detail.

Wicke and Weiske did not find, according to their table, any marked decrease in the quantity of urine by increasing the quantity of fat in the diet, although their tables tend to show a decrease, while in the case of the carnivora we have got a very marked decrease.

We, therefore, can conclude that the normal dogs here shown are well capable of acting as standards of comparison to the results obtained after the removal of the large intestine, since the results compare very favourably with those found in the case of the herbivora ('Zeit. f. Physiol. Chem.,' 1895, vol. 21, p. 42; 1896, vol. 22, pp. 137 and 265).

distance was 5·5 cm., and from the junction to the outside of the anus was 10 cm. when stretched. The transverse measurement of the cæcal end of the large intestine was 5 cm., while the rectal end had dilated to no less than 10 cm. Thus a pouch had been formed above the anus which accounted for the changes in the fæces which took place during the time of observation. For when the animal first was put on solid diet, some three weeks after the operation, the fæces passed were always fluid, while, later on, they were more or less formed, and, as will be seen presently, became really of almost a normal consistence.

Dog 3.—Table IV. In this bitch three periods were analysed. In (*a*), first period, the diet contained 6·05 grams of nitrogen and 11·73 grams of fat; five consecutive days were analysed. The weight remained constant at 6·10 kilos. The daily quantity of urine passed varied from 210 to 135 c.c., while the specific gravity was between 1025 and 1044. The quantity of nitrogen excreted in the urine rose and fell between 5·244 and 5·390 grams; so that throughout these five days the nitrogen equilibrium was well kept up. The quantity of fæces daily eliminated was very irregular. The first day no less than 70·76 grams of fæces were passed, that is to say within twenty-four hours of the diet. Next day only 7·50 grams, and on the third day none at all were passed; on the other two days during which fæces were passed the amount was 65·77 and 57·72 grams. In consequence of this great difference in the quantity of fæces daily passed, the nitrogen contained in them was also variable, varying from no less than 0·176 to 1·488 grams.

As far as the fat analysis is concerned the average was obtained from the figures for only three days. At the same time as the average thus obtained came out roughly what one would expect, it would appear the dog in every way behaved as a normal dog. Naturally, owing to the absence of fæces on one day (the third), the percentage of absorption during the various days varied notably, both in the case of nitrogen and fat.

(*b*) The dog was now put on the same nitrogenous and carbohydrate diet, but the fat increased to 36·73 grams. The quantity of urine passed varied from 150 to 216 c.c., while the specific gravity fluctuated from 1028 to 1038, the nitrogen in the urine varying from 4·188 to 5·491 grams.

As far as the fæces were concerned during these four days, one day no fæces were passed; on the other days the quantity varied from 43·78 to 51·97 grams, the quantity of nitrogen, however, varying very little, viz., from 0·753 to 0·918 gram. The fat on the first day was very high, being 2·219 grams, while the lowest limit was 1·543 grams. In this stage also the absorption varied on the various days from 85 to 88 per cent. of the total nitrogen, and from 94 to 96 per cent. of the total fat. During this period the dog steadily increased in weight.

Table IV.—Dog 3. Partial Removal of the Large Intestine. The middle 17 cm. being removed and only 15 cm. being left. The lower 10 cm. dilating into a pouch after twenty-two months.

Increasing Quantities of Fat being added to a diet containing 100 grams of Sterilised Beef and 100 grams of Biscuit. Figures in ( ) not complete average, owing to one analysis in each case being lost.

Day.	Weight.	Diet.		Urine.			Fæces.			Absorbed.	
		N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
(*a*) 12	6·18	6·05	11·73	210	1025	5·930	70·76	1·146	..	81·06	
13	6·18	6·05	11·73	200	1030	5·601	7·50	0·176	0·267	97·07	97·72
14	6·18	6·05	11·73	180	1032	5·873	..	no fæces			
15	6·18	6·05	11·73	135	1044	5·333	63·77	1·150	2·211	80·99	81·15
16	6·18	6·05	11·73	135	1044	5·244	57·72	1·488	2·390	75·40	79·62
Average	6·18	6·05	11·73	172	1035	5·596	39·95	0·792	(1·217)	86·91	(86)
(*b*) 19	6·19	6·05	36·73	160	1031	5·491	49·80	0·786	2·219	87·01	93·96
20	6·20	6·05	36·73	216	1028	5·251		no fæces			
21	6·26	6·05	36·73	150	1028	4·188	51·97	0·918	1·985	84·83	94·60
22	6·26	6·05	36·73	150	1038	5·032	43·78	0·753	1·543	87·55	95·80
Average	6·23	6·05	36·73	169	1031	4·991	36·39	0·614	1·437	89·85	96·09
(*c*) 30	6·68	6·05	51·73	120	1048	4·307	54·38	0·918	3·050	84·83	94·10
31	6·75	6·05	51·73	112	1045	4·763	24·60	0·351	0·762	94·20	98·53
32	6·75	6·05	51·73	130	1040	4·971	39·70	0·779	..	87·12	
33	6·75	6·05	51·73	100	1052	..	19·69	0·322	0·553	94·68	98·93
34	6·75	6·05	51·73	96	1052	..	53·18	0·752	1·602	87·14	96·90
Average	6·74	6·05	51·73	112	1048	(4·680)	38·31	0·624	1·492	89·69	(97)

(*c*) Another period of five days was next investigated, when the diet was increased still more to 51·73 grams of fat. The quantity of urine now passed varied from 96 to 130 c.c., with a specific gravity of 1040 to 1052. The nitrogen was only analysed in the urine during three days out of the five in consequence of an unfortunate accident. It varied from 4·307 to 4·971 grams, and remained pretty constant during this period. The dog daily passed his fæces, and the quantity in consequence appears smaller than in the preceding cases, varying from 19·69 to 54·38 grams; at the same time the quantity of nitrogen contained in the fæces varied from 0·322 to 0·918 gram. On the third day of this period the fat in the fæces was lost; on the other days the quantity varied from 3·050 to 1·602 grams.

With this we get a varied absorption of proteids, the quantity varying from 84·83 to 94·68, while as far as the fat is concerned it varied from 94·10 to 98·93 per cent.

Having considered this table in detail, we can now consider the average of the three periods (*a*), (*b*), (*c*) in this case, where partial removal of the large intestine had been carried out.

It was found in this partial removal, even after shrinkage of the part isolated, that over a half of the total length of the large intestine had been removed. The dilatation of the rectum accounts for the retention of fæces on some days so as to cause constipation.

From Table V the average of the three periods, the addition of an increasing quantity of fat being added to a fixed nitrogen diet, is seen to cause a decrease in the quantity of urine, the amount falling from 172 to 169 c.c., and then to 112 c.c. The specific gravity did not quite coincide, as it did not rise steadily in the three periods.

As far as the nitrogen in the urine is concerned, we see also that as the fat was increased, so the quantity of nitrogen in the urine fell from 5·596 to 4·991 grams and 4·680 grams. So that as in the normal dog the nitrogen sparing properties of the fat are well brought out.

The quantity of the fæces for all practical purposes is not much influenced by increasing the quantity of fat, and certainly not in the degree which would seem to occur in the two normal dogs, in both of which, on the fat being increased in the diet, the quantity of fæces were augmented. The variation may be in part explained by the constipation which occurred in periods (*a*) and (*b*).

The nitrogen of the fæces in this dog, if anything, was decreased in quantity by increasing the fat, for whereas during the first five days, period (*a*), 0·792 gram of nitrogen was daily eliminated in the fæces, on the diet being increased to 36·73 grams of fat during the four days of period (*b*), the nitrogen was increased to 0·614 gram, and during period (*c*), when no less than 51·73 grams of fat were being taken, the nitrogen amounted to 0·624 gram.

With regard to the fat in the fæces, the table shows that the quan-

Table V.—Average of Partial Removal of Large Intestine on a Diet containing an Increased Quantity of Fat. Figures in ( ) not complete average, owing to an analysis in each case being lost.

No. of experiment.	Weight.	Duration of observation.	Diet.		Urine.			Fæces.			Absorbed.	
			N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	days.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
3 (*a*)	6·18	5	6·05	11·73	172	1035	5·596	39·95	0·792	(1·217)	86·91	(86)
(*b*)	6·23	4	6·05	36·73	169	1031	4·991	36·39	0·614	1·437	89·85	96·09
(*c*)	6·75	5	6·05	51·73	112	1048	(4·680)	38·31	0·624	(1·492)	89·69	(97)

tity, 1·217 grams, in the first period was increased to 1·437 grams, when the diet contained 36·73 grams of fat, and on increasing the diet to 51·73 grams of fat, it rose to 1·492 grams.

When we compare this to what we find in normal dogs, we see the total quantity of fat daily eliminated was really higher than what occurred in the normal dogs, for in dog 1, on practically the same diet, the quantity of the three periods (*a*), (*b*), (*c*) was 0·733, 0·971, and 0·264 gram.

We now turn to the table of absorption. On the diet containing 11·73 grams of fat, the nitrogen absorption was 86·91 per cent. as against in the normal dog 92·71 per cent. On increasing the fat to 36·73 grams the nitrogen absorption rose to 89·85 per cent. On increasing the amount of fat in the diet to 51·73 grams it fell slightly to 89·69 per cent., while the corresponding absorption in the normal dog was 91·25 and 90·26 per cent. From this we see that on comparing the two animals together, we have a slight decrease in the percentage of absorption of proteids from the alimentary tract caused by partial removal of the large intestine. It also follows that contrary to what one finds in normal dogs, namely, that on increasing the fat in the diet there is an apparently decreased absorption, one finds in the dog from which the larger part of the large gut has been removed, on the other hand, an increased absorption of nitrogen.

Turning now to the fat, the average for which the periods (*a*) and (*c*) is not complete, for the whole period analysed it appears that 86* per cent. of the fat is absorbed as against 93 per cent. in the normal dog, while when the fat is increased 96·09 per cent. is absorbed in period (*b*) and 97 per cent. in period (*c*). So that while it is seen that on increasing the fat the percentage absorption is increased as in the normal dog, at the same time it must be noted that with a small fat diet the absorption appears to have been less than normal, although this may not be quite correct, since the average, as already stated, is not for the total period.

On the increased fat in the diet of stage (*b*) the percentage absorption of fat practically corresponds to what one finds in the normal dog, in this case being 96·09 per cent.; and again when the fat was increased to 51·73 grams, the absorption rose to 97 per cent., the corresponding figure in the normal dog with 62·04 grams of fat being 97·96 per cent.

It may therefore be considered that after partial removal of the large intestine the influence on general metabolism, as indicated by the urine, is very little; that increasing the fat in the diet causes, as in the normal dog, a steady decrease in the quantity of urine, and also causes a sparing of nitrogen to the body, and therefore decrease of nitrogen in the urine.

* This figure is probably too low. See Table V.

Increasing the fat in the diet of this dog did not increase the quantity of fæces excreted, and still further did not increase the quantity of nitrogen contained in the fæces as occurred in the normal dogs. At the same time it increased the quantity of fat found in the fæces.

The percentage of nitrogen absorbed under the same circumstances was decreased, but instead of decreasing with the increase of fat as in normal dogs, it practically remains the same, or if anything increases. In fact, the percentage absorption of fat would appear to be exactly the same as in the normal dogs.

The Influence of Complete Removal of the Large Intestine on Metabolism.

Having now finished the consideration of the dog in which the large intestine was partially removed, we will next examine the cases of the two dogs in which the whole of the large intestine was entirely removed together with the cæcum. In these instances the small intestine, just above its junction with the cæcum, was sewn into the rectum as close to the anus as possible; in fact, this was in every experiment found by post mortem to be under 6 cm.

The difficulty in the after-treatment consists in the straining movements of the anus being apt to tear the sutures.

During the first few days after the operation the animal was fed on milk and beef-tea; later on, the diet was slowly increased, and finally the animal was able to take the normal diet. For some reason or other they were unable to take such large quantities of fat as normal dogs, for when the fat was increased to a certain amount, they either had a severe diarrhœa or refused their food altogether, so that it was not possible to obtain the effect of the marked increase of fat on the composition of the fæces so clearly as in the normal dogs.

Dog 4.—In dog 4 the large intestine was entirely removed one month previous to the beginning of the metabolism observations, during which time the diet had been steadily increased as already described, and the animal had begun to feed well on its mixed diet. When its body weight had reached 4 kilos. the dog was then placed on the meat and biscuit diet, and the employment of sterilised meat was begun eight days before the commencement of the analysis.

The general results are included in Table VI.

In this case (dog 4) four periods were investigated, two periods in which the amount of fat given was 9·71 grams, the nitrogen in the proteid amounting to 6·80 grams; in the next two periods the fat was increased to 29·71 grams, while the meat and biscuit diet remained the same. In this case it was found impossible to increase the fat still more, as the dog then always refused his food.

(*a*) During the first period the weight remained constant, and the quantity of water passed fluctuated from 110 to 275 c.c., with a specific

Table VI.—Dog 4. The Influence of an Increasing Quantity of Fat to a Staple Proteid and Carbohydrate Diet on the general Metabolism and Absorption after Complete Removal of the Large Intestine one month previous to the commencement of Experiment. The diet consisted of 100 grams of Sterilised Meat and 100 grams of Biscuit.

Day.	Weight.	Diet.		Urine.			Fæces.			Absorbed	
		N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
(*a*) 8	4·05	6·80	9·71	110	1042	4·427	56·70	0·907	0·548	86·67	94·36
9	4·05	6·80	9·71	170	1028	4·815	97·82	1·383	0·734	79·68	92·44
10	4·05	6·80	9·71	210	1014	4·120	76·27	1·022	0·777	84·98	92·00
11	4·05	6·80	9·71	275	1016	4·418	71·42	0·945	1·049	86·11	89·20
Average	4·05	6·80	9·71	191	1025	4·445	75·55	1·064	0·777	84·36	92·00
(*b*) 15	4·05	6·80	9·71	395	1012	4·405	79·60	1·258	0·632	81·51	93·49
16	4·05	6·80	9·71	309	1013	4·290	69·43	1·044	0·713	84·66	92·66
17	4·11	6·80	9·71	330	1018	4·427	81·12	1·036	0·560	84·77	94·23
18	4·11	6·80	9·71	..	..	..	68·67	0·987	0·513	85·49	94·72
Average	4·08	6·80	9·71	341	1014	4·374	74·41	1·081	0·605	84·11	93·77
(*c*) 22	4·17	6·80	29·71	121	1029	3·010	82·56	1·162	0·805	82·92	97·29
23	4·17	6·80	29·71	200	1018	3·282	84·64	1·144	0·850	83·19	97·14
24	4·17	6·80	29·71	240	1014	3·344	83·09	1·005	0·699	85·23	97·65
25	4·17	6·80	29·71	265	1015	3·337	84·82	1·042	0·721	84·69	97·58
Average	4·17	6·80	29·71	207	1019	3·243	83·78	1·088	0·769	84·01	97·41
(*d*) 29	4·24	6·80	29·71	52	1034	1·330	82·90	1·180	1·248	82·66	95·80
30	4·30	6·80	29·71	300	1018	3·220	81·53	1·214	0·660	82·16	97·78
31	4·31	6·80	29·71	190	1023	3·960	85·10	0·918	0·710	86·51	97·61
32	4·31	6·80	29·71	240	1018	3·620	84·45	1·079	..	85·90	
Average	4·29	6·80	29·71	198	1023	2·965	83·49	1·093	0·873	84·14	97·06

gravity varying from 1016 to 1042. In spite of the great fluctuation in the quantity of water, the quantity of nitrogen daily eliminated in the urine varied only from 4·815 to 4·120 grams, so that there was no great difference per diem.

The quantity of fæces which were passed daily varied from 56·70 to 97·82 grams, and the nitrogen contained in the fæces fluctuated from 0·907 to 1·383 grams. The fat in the fæces during the eighth, ninth, and tenth days varied from 0·548 to 0·777 gram, while on the eleventh day, from some unknown reason, in spite of the fæces not having increased markedly in quantity, the quantity of fat contained therein was 1·041 grams. The absorption of nitrogen, in consequence of the varied quantities passed on the different days, fluctuated somewhat considerably, consequently another period of analysis was done on exactly the same diet for another period of four days, the diet in the interval having been kept the same.

(*b*) In this second stage of the experiment a part of the urine was unfortunately lost on the eighteenth day. The daily quantity varied from 309 to 395 c.c., with a specific gravity of 1012 to 1018. That is to say, the quantity was very much increased above that found during the previous four days, and the specific gravity very much lower. The quantity of nitrogen in the urine during these three days varied from 4·290 to 4·427 grams, so that that factor tallied very much with that found on the previous day.

The daily quantities of fæces were also more equal than on the previous four days, as they varied from 68·67 to 81·12 grams, the nitrogen varying from 1·258 to 0·987 gram; the daily fat in this case being fairly equal, and showing no marked rise as in the preceding period, varying from 0·713 to 0·513 gram.

(*c*) During the next (the third) period the quantity of fat was increased to 29·71 grams on the nineteenth day; and the analysis began on the twenty-second. The weight went up from 4·11 to 4·17 kilos. The quantity of urine passed fluctuated from 121 to 265 c.c., with a specific gravity varying from 1014 to 1029. The nitrogen in the urine decreased in amount, fluctuating from 3·010 to 3·344 grams. The quantities of fæces observed daily were very nearly equal, varying from 82·56 to 84·82 grams, the nitrogen in the fæces remaining very constant, the fluctuations being only between 1·005 and 1·162 grams, and the fat also remained very constant, varying from 0·699 to 0·850 gram.

(*d*) In the final period (the fourth), the food being in the interval kept exactly the same, the animal went up somewhat in weight, rising to 4·31 kilos. The quantity of urine passed varied from 52 to 240 c.c.; but the small quantity of urine passed on the twenty-ninth day is in all probability an error, as the specific gravity on that occasion was practically the same as on other days. Leaving this day's amount

out of account, the quantity of urine collected on the other three days was 310, 190, and 240 c.c. respectively, with a specific gravity varying from 1018 to 1023. The nitrogen observed remained throughout the period very constant, varying from 3·220 to 3·960 grams. The quantity of fæces again here, as in the preceding period, was fairly equal in amount, the quantity varying from 81·53 to 85·10 grams. The quantity of nitrogen in the fæces during these four days varied from 0·918 to 1·214 grams; the smallest quantity was found on the day on which the largest quantity of fæces was passed, that is to say, on the thirty-first day. The fat was only analysed on three out of the four days.

Before discussing the average results of these four periods of analysis it would be well to discuss the facts of the next experiment, in which the large intestine was also entirely removed, so that the two averages may be compared together.

In this dog only two periods were investigated, to try to fill up the gap in the observations just described, which were incomplete owing to the impossibility of increasing the fat in the dietary in sufficient degree.

Dog 5.—The first diet was started ten days before the analysis was commenced. During the first period of five days the animal received 6·26 grams of nitrogen in his diet, and 11·55 grams of fat. The quantity of urine during these five days varied from 75 to 120 c.c., the specific gravity varying from 1028 to 1052, the nitrogen, however, remaining pretty constant throughout, only varying from 4·110 to 4·508 grams. The quantity of fæces steadily increased in amount during the five days, rising from 46·93 to 94·20 grams, the nitrogen thereof also rising as the fæces increased, although it rose still more on the fourteenth day, when the fæces were not quite so high as on the thirteenth; it varied from 1·194 to 0·796 gram.

The quantity of fat was only analysed on four of these days, and varied from 0·380 to 0·618 gram.

During the next period of four days the fat in the diet was increased to 41·55 grams; however, during the last two days (twenty-fifth and twenty-sixth) the animal lost his appetite, although from the fifteenth to the twenty-fifth he had steadily kept up his diet and gone up in weight, and even stopping the fat for an interval and trying to administer it again was unsuccessful. Consequently, although the four days were analysed, only the first two days can be taken as an average on this diet.

We see on looking at the table that the quantity of fæces daily passed varied very considerably, and therefore the results obtained during the four days cannot be considered definite, but I have included the facts as an addition to the preceding observations.

On the increased fat diet it will be seen that the quantity of urine

Table VII.—Dog 5. The Influence of an Increasing Quantity of Fat to a Staple Proteid and Carbohydrate Diet on the general Metabolism and Absorption after Complete Removal of the Large Intestine two months previous to the commencement of experiment.

The diet consisted of 100 grams of Sterilised Meat and 100 grams of Biscuit.

Day.	Weight.	Diet.		Urine.			Fæces.			Absorbed.	
		N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Fat.
	kilos.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
10	6·30	6·26	11·55	90	1052	4·508	46·93	0·796	0·618	87·29	94·65
11	6·30	6·26	11·55	86	1042	4·110	59·30	0·974	0·380	84·45	96·71
12	6·30	6·26	11·55	120	1028	4·461	83·80	1·077	0·599	82·80	94·81
13	6·30	6·26	11·55	96	1048	4·343	92·20	1·114	0·614	82·21	94·68
14	6·30	6·26	11·55	75	1052	4·459	86·55	1·194	..	80·93	
Average	6·30	6·26	11·55	93	1044	4·376	74·16	1·031	(0·553)	83·54	(95)
23	6·63	6·26	41·55	96	1026	2·422	64·55	0·743	0·936	88·13	97·75
24	6·62	6·26	41·55	85	1030	2·408	54·20	0·468	0·701	92·53	98·31
Average	6·58	6·26	41·55	91	1028	2·415	59·38	0·606	0·819	90·33	98·03
25	6·53	6·26	41·55	82	1030	2·748	30·38	0·398	0·507*		
26	6 30	6·26	41·55	100	1022	2·406	14·77†				

* Not taken all food.

† Not taken all food. Urine, on standing, deposited indigo.

during the first two days was 96 c.c. and 85 c.c., with a specific gravity of 1026 and 1030. The quantity of nitrogen in the urine fell very considerably to 2·422 and 2·408 grams, while the quantity of fæces also was not very high, being 64·55 to 54·20 grams. The nitrogen in the fæces was lower than in the former period, being only 0·743 and 0·468 gram. The quantity of fat found was somewhat greater, being 0·936 to 0·701 gram.

We now come to consider Table VIII, in which are given the averages of the results obtained from these last two dogs, in which the large intestine had been entirely removed.

In dog 4 the quantity of urine during the two periods in which 9·71 grams of fat were given varied very considerably, being 191 and 341 c.c. respectively; and the specific gravity also varied, being 1025 and 1014. At the same time the quantity of nitrogen in the urine during these two periods remained pretty much the same, being 4·445 and 4·374 grams. The nitrogen in the fæces also remained constant, being 1·064 and 1·081 grams, the fat being 0·777 and 0·605 gram.

We see, comparing these with the normal dog on the same quantity of fat, that the quantity of fæces is very much larger, in fact nearly double the quantity found in the normal dog on practically the same diet, and at the same time the nitrogen in the fæces is increased, being more than double, or at any rate double the quantity in a normal dog, whereas the fat in the fæces is practically the same as in a normal dog on a diet containing this amount of fat.

As far as the absorption of proteids is concerned it is 84·36 and 84·11 per cent., while in a normal dog we find that on this diet roughly 92·71 and 91·29 per cent. was absorbed, and in the dog in which the large intestine was partially removed 86·91 and 89·85 per cent. was absorbed. We may, therefore, take it that this dog shows a still greater decrease in the absorption of nitrogen than after the partial removal of the large intestine, and that the absorption of nitrogen is very much influenced by the absence of the large intestine.

During the next two periods 29·71 grams of fat were taken, and the animals increased in weight during these two periods, also the quantity of urine varied very considerably, being 207 and 198 c.c., with a specific gravity of 1019 and 1023.

The quantity of nitrogen excreted in these two periods was 3·243 and 2·965 grams, so that the increase of fat caused a decrease in the quantity of nitrogen in the urine; that is to say, a proteid sparing influence, the same as in the normal dog. As far as the urine is concerned, and comparing these two periods with the former two periods, it would seem as if the quantity of water absorbed is decreased by the increased quantity of fat. At the same time this is not at all so well brought out as in the case of the normal dogs, or even in the dog with partial removal of the large intestine.

Table VIII.—Average, after Total Removal of Large Intestine, of Metabolism in Two Dogs on an Increasing Quantity of Fat in the Diet.

Figures in ( ) not complete averages.

No. of experiment.	Weight.	Duration of observation.	Diet.		Urine.			Fæces.			Absorbed.	
			N.	Fat.	Quantity.	Sp. gr.	N.	Quantity.	N.	Fat.	N.	Ft.
	kilos.	days.	grams.	grams.	c.c.		grams.	grams.	grams.	grams.	per cent.	per cent.
4 (*a*)	4·05	4	6·80	9·71	191	1025	4·445	75·55	1·064	0·777	84·36	92·00
(*b*)	4·08	4	6·80	9·71	341	1014	4·374	74·71	1·081	0·605	84·11	93·77
(*c*)	4·17	4	6·80	29·71	207	1019	3·243	83·78	1·088	0·769	84·01	97·41
(*d*)	4·29	4	6·80	29·71	198	1023	2·965	83·49	1·098	0·873	84·14	97·06
5 (*a*)	6·30	5	6·26	11·55	93	1044	4·376	71·16	1·031	(0·553)	83·54	(95)
(*b*)	6·58	2	6·26	41·55	91	1028	2·415	59·38	0·606	0·819	90·33	98·03

The quantity of fæces during the two periods is 83·78 and 83·49 grams, so that the increase of fat has undoubtedly caused in this dog an increased quantity of fæces. The nitrogen during these two periods was 1·098 and 1·088 grams, so that the increase in the quantity of fat in the diet has caused a slight increase in the quantity of nitrogen in the fæces, the same as we find in the normal dogs. The quantity of fat in the two periods was 0·769 and 0·873 gram, that is to say, a slight tendency to an increase, through the increased quantity of fat in the diet.

We thus see that the dog after total removal of the large intestine shows a marked increase in the quantity of nitrogen in the fæces; at the same time, in spite of this increase, it can be still more increased by increasing the fat given in the diet. As far as the fat is concerned the quantity of fat in the normal dog's fæces, as compared with that after removal of the large intestine, is practically the same. It is thus well borne out that as far as the fats are concerned they are well absorbed by the small intestine, the large intestine having no influence whatever on their absorption.

On the other hand, as far as the proteids are concerned, they are not so well absorbed—at least 10 per cent. less—but there is an increase in the quantity of proteid or nitrogen in the fæces of the dogs in which the large intestine has been removed, and that this increase is slightly augmented by increasing the quantity of the fat in the diet, as in normal dogs; at the same time the decrease in absorption, as thus indicated in normal dogs, is not so marked, if at all marked, after removal of the large intestine.

Having considered the general metabolism, and having seen how the quantity of fæces is increased in dogs in which the large intestine has been removed, we now come to consider the fæces more carefully as regards their general appearance and the quantity of water.

The Influence of Diet on the Daily Quantity and the Amount of Water in the Fæces when the Large Intestine is Removed.

Immediately after the operation, the dogs for the first few days took practically no food, and then were put on a milk diet, which consequently caused the light motions so typical of this diet. When the diet was slowly converted into that of biscuit and meat, on which a normal dog would be passing well-formed fæces, the dog continued to pass a semi-fluid motion. In the case of the partial removal of the large intestine this was well marked, so that the dog for the first few weeks suffered from more or less diarrhœa. Before death, however, throughout the time in which metabolism experiments were being done, the dog passed fæces almost of normal consistence, and, as is seen by the post mortem, this is to be explained by the sack-like enlargement of the rectum.

In normal dog 1, Table IX, are placed together the analyses of the fæces, as influenced by the increase of fat in the diet. The fat is seen here to cause not only an increase in the quantity of fæces, but also an increase in the total quantity of water excreted in the fæces. While we saw that increasing the fat in the normal dog's diet caused a decrease in the quantity of urine passed, we find here that it causes an increase in the quantity of water eliminated by the fæces, being on the first diet 12·79 grams, then 13·79 grams, and on the diet rich in fat no less than 14·32 grams. The percentage of water in the total fæces, however, decreases with the increased quantity of fat, as it falls from an average of 70·98 to 67·85 and 67·87 per cent. Thus the increased quantity of water eliminated by the fæces is due to the increased quantity of fæces, and not to an increased percentage of water present.

Table IX.—Normal Dog 1. Showing the Influence of an Increasing Quantity of Fat in the Diet on the Quantity of Fæces and the Water contained in them.

Day.	Diet.		Fæces.		
	N.	Fat.	Quantity.	Water.	
				Total.	Per cent.
	grams.	grams.	grams.	grams.	
8	4·817	12·043	17·79	13·39	72·25
9	4·817	12·043	18·65	16·11	75·63
10	4·817	12·043	18·50	13·06	76·64
11	4·817	12·043	19·51	12·59	59·39
Average	4·817	12·043	18·61	12·79	70·98
15	4·817	32·043	24·67	16·53	66·99
16	4·817	32·043	20·53	13·71	66·79
17	4·817	32·043	18·95	1·284	67·73
18	4·817	32·043	17·52	12·07	70·30
Average	4·817	32·043	20·42	13·79	67·95
22	4·817	62·043	19·62	13·42	68·40
23	4·817	62·043	28·26	18·59	65·79
24	4·817	62·043	17·52	11·94	68·15
25	4·817	62·043	25·41	13·31	68·13
Average	4·817	62·043	22·70	14·32	67·87

In dog 2, Table X, we have two periods in which the quantity of fat remained constant. As far as the quantity of fæces was concerned we found during these two periods the quantity pretty nearly the

same, at the same time the quantity of water differs somewhat considerably.

Table X.—Normal Dog 2. Showing the Influence of an Increasing Quantity of Fat in the Diet on the Quantity of Fæces and Water of the Fæces.

Day.	Diet.		Fæces.		
	N.	Fat.	Quantity.	Water.	
				Total.	Per cent.
	grams.	grams.	grams.	grams.	
9	7·995	15·200	22·70	16·17	71·22
10	7·995	15·200	27·45	18·03	65·68
11	7·995	15·200	25·93	14·08	54·30
12	7·995	15·200	50·59	31·30	61·85
Average	7·995	15·200	31·67	19·90	63·26
14	7·995	15·200	33·30	22·42	67·31
15	7·995	15·200	17·53	10·29	58·69
16	7·995	15·200	40·45	26·63	65·82
17	7·995	15·200	43·20	28·77	66·59
Average	7·995	15·200	33·62	22·03	64·60
21	7·995	65·190	29·36	17·95	61·14
22	7·995	65·190	34·41	21·20	61·61
23	7·995	65·190	39·17	29·19	55·65
24	7·995	65·190	42·09	26·32	62·68
Average	7·995	65·190	36·26	23·67	60·52

The percentage of water in this dog was less than the percentage on the corresponding diet in the first normal dog, being only 63·26 and 64·60 per cent. On increasing the fat in the diet, the quantity of fæces, as in the former normal dog, increased, and the total water eliminated also increased. The percentage of water, however, decreased, so that though the increase of fat in the diet caused in this dog, as in the former, an increased elimination of water in the fæces, this was due to an increased quantity of fæces passed, and not due to any increase of the fluid constituent thereof.

We now come to the dog in which the large intestine was partially removed, Table XI, and in which, as we have already seen, there was a dilatation of the rectum. In spite of this latter condition the absorption of this dog differed somewhat from the absorption of the normal dog. In this dog, during the three periods analysed, the quantity of fæces fluctuated on different days, and during the first two periods

there was occasionally an interval of a day without any fæces being passed. In consequence of this constipation one would expect the percentage of water to be small; it is seen that in this dog the percentage of water during the first period was 50·96, and with a slight increase of fat rose, instead of fell, to 54·59; still further rising on the diet rich in fat to 72·46. The quantity of water also rose; but in this dog, by increase of fat in the diet, one got not only an increase in the total quantity of water eliminated by the fæces but also an increase in the percentage.

Table XI.—Partial Removal of Large Intestine, showing the Influence of an Increasing Quantity of Fat in the Diet on the Quantity of Fæces and the Water of the Fæces.

Day.	Diet.		Fæces.		
	N.	Fat.	Quantity.	Water.	
				Total.	Per cent.
	grams.	grams.	grams.	grams.	
12	6·05	11·73	70·76	47·24	66·77
13	6·05	11·73	7·50	4·88	55·02
14	6·05	11·73		no fæces]	
15	6·05	11·73	63·77	42·93	67·32
16	6·05	11·73	57·72	32·15	55·69
Average	6·05	11·73	39·95	25·44	50·96
19	6·05	36·73	49·80	35·33	70·94
20	6·05	36·73		no fæces	
21	6·05	36·73	51·97	37·29	71·75
22	6·05	36·73	43·78	33·13	75·67
Average	6·05	36·73	36·39	26·44	54·59
33	6·05	51·73	54·38	39·10	64·63
34	6·05	51·73	24·60	18·97	77·12
35	6·05	51·73	39·70	27·95	70·39
36	6·05	51·73	19·69	15·11	74·20
37	6·05	51·73	53·18	40·39	75·94
Average	6·05	51·73	38·31	28·30	72·46

We now come to the dogs in which the total removal of the large intestine is carried out. We have in Table XII two groups of results, which represent two periods during which the dog received 9·71 grams of fat, and two periods in which 29·71 grams of fat were given. As in the normal dogs, we have here also an increase in the quantity of fæces, produced by increasing the quantity of fat, and also an increase in the

Table XII.—Dog 4. Total Removal of the Large Intestine, showing the Influence of an Increasing Quantity of Fat in the Diet on the Quantity of Fæces and the Water in the Fæces.

Day.	Diet.		Fæces.		
	N.	Fat.	Quantity.	Water.	
				Total.	Per cent.
	grams.	grams.	grams.	grams.	
8	6·80	9·71	56·70	40·93	72·20
9	6·80	9·71	97·82	74·68	77·36
10	6·80	9·71	76·27	60·30	79·06
11	6·80	9·71	71·42	55·51	77·73
Average	6·80	9·71	75·55	58·11	76·59
15	6·80	9·71	79·60	60·10	76·45
16	6·80	9·71	69·43	51·95	74·83
17	6·80	9·71	81·12	63·65	78·47
18	6·80	9·71	68·67	51·76	75·37
Average	6·80	9·71	74·71	56·87	76·26
22	6·80	29·71	82·56	64·55	78·19
23	6·80	29·71	84·64	66·83	78·96
24	6·80	29·71	83·09	66·91	80·53
25	6·80	29·71	84·82	67·96	80·12
Average	6·80	29·71	83·78	66·56	79·45
29	6·80	29·71	82·90	63·56	76·67
30	6·80	29·71	81·53	63·94	78·43
31	6·80	29·71	85·10	70·13	82·41
32	6·80	29·71	84·45	66·71	78·99
Average	6·80	29·71	83·49	66·09	79·13

quantity of water daily eliminated. At the same time there is an increase in the percentage of water from 76·59 and 76·26 to 79·45 and 79·13 per cent.

In dog 5, Table XIII, in which the large intestine was removed, we also have an increase in the percentage of water by increasing the fat during the two days on which it was analysed; at the same time the total quantity of water, as well as the quantity of fæces, was not increased, but this may have been due in this case, as already explained, to the fact that a perfect determination of the periods during which the fæces were collected could not be obtained.

When we compare the averages, Table XIV, of these various experiments, we find that whereas a normal dog excretes about 18 to 22 grams of fæces, containing from 13 to 14 c.c. of water per diem on the

Table XIII.—Dog 5. Total Removal of the Large Intestine, showing the Influence of an Increasing Quantity of Fat in the Diet on the Quantity of the Fæces and the Water of the Fæces.

Day.	Diet.		Fæces.		
	N.	Fat.	Quantity.	Water.	
				Total.	Per cent.
	grams.	grams.	grams.	grams.	
10	6·262	11·548	46·93	34·70	73·94
11	6·26	11·55	93·30	44·34	74·77
12	6·26	11·55	83·80	67·71	80·80
13	6·26	11·55	94·20	78·09	82·94
14	6·26	11·55	86·55	68·01	82·98
Average	6·26	11·55	74·16	58·57	79·09
23	6·286	41·55	64·55	52·06	80·65
24	6·26	41·55	54·20	46·93	86·58
Average	6·26	41·55	59·38	49·49	83·62

various amounts of fat diet, a dog, after the total removal of the large intestine, excretes no less than from 75 to 84 grams of fæces, containing from 57 to 67 c.c. of water; and further, that whereas the percentage of water in the fæces in a normal dog varies roughly between 60 and 70, in dogs without a large intestine it varies between 77 and 84 per cent.

In the case of partial removal of the large intestine, during the time in which there was constipation and a day was consequently missed in the action of the bowels, the percentage of water fell to 50·96; but on the other occasions, when the bowels were acting regularly, the percentage tended to be high, 72·46; in fact, comparing fairly with those dogs in which the large intestine was removed.

The interesting fact brought out by this experiment is that in the normal dog the increase of fat, causing an increased quantity of fæces, is accompanied by an increased elimination of water, and at the same time by a decrease in the percentage of water eliminated, and that this relative decrease is due to an increase of solids in the fæces.

Fr. Müller* had already shown that increasing the fat in the diet of a dog fed on meat caused a decrease in the percentage of water contained in the fæces. Thus a dog on 1500 grams of meat, with 30 grams of fat, passed fæces containing 69·6 per cent. of water; but on increasing the fat of the diet to 60 grams it fell to 64·9 per cent., and still further with 250 grams to only 53·0 per cent.

* Fr. Müller, *loc. cit.*, p. 360.

Table XIV.—The Influence of an Increasing Quantity of Fat in the Diet on the Quantity of Fæces and Water in the Fæces.

No.	Duration of observation.	Diet.		Fæces.		
		N.	Fat.	Quantity.	Water.	
					Total.	Per cent.
	days.	grams.	grams.	grams.	grams.	
Average of Two Normal Dogs.						
1 (*a*)	4	4·82	12·04	18·61	12·79	70·78
(*b*)	4	4·82	32·04	20·42	13·79	67·95
(*c*)	4	4·82	62·04	22·70	14·32	67·87
2 (*a*)	4	8·00	15·20	31·67	19·90	63·26
(*b*)	4	8·00	15·20	33·62	22·03	64·60
(*c*)	4	8·00	65·19	36·26	23·67	60·52
Average of Partial Removal of Large Intestine.						
3 (*a*)	5	6·05	11·73	39·95	25·44	50·96*
(*b*)	4	6·05	36·73	36·39	26·44	54·59*
(*c*)	5	6·05	51·73	38·31	28·30	72·46
Average of Total Removal of Large Intestine.						
4 (*a*)	4	6·80	9·71	75·55	58·11	76·59
(*b*)	4	6·80	9·71	74·71	56·87	76·26
(*c*)	4	6·80	29·71	83·78	66·56	79·45
(*d*)	4	6·80	29·71	83·49	66·09	79·13
5 (*a*)	5	6·26	11·55	74·16	58·57	79·09
(*b*)	2	6·26	41·55	59·38	49·49	83·62

On the other hand I find that in dogs without the large intestine the increase of fat, although it is accompanied by an increase in the quantity of fæces and increase in the quantity of water, is not accompanied by any decrease of percentage of water eliminated in the fæces.

The breaking up of Fat in the Alimentary Canal in Normal Dogs, and after Partial or Complete Removal of the Large Intestine.

With regard to the breaking up of fat in the alimentary canal in the absence of the large intestine, analyses were made on each of the preceding dogs of the fat, or rather total ether extract, as regards the quantity of neutral fat, free fatty acids, fat acids as soaps, and cholesterin it contained.

* One day passed no fæces.

Table XV.—Composition of Ether Extract of Fæces. Normal Dog 2 during the first period of four days received daily 15·20 grams of Fat, while during the second period of three days daily 65·19 grams of Fat.

Day.	Total ether extract.		Neutral fat.		Free fat acids.		Fat acids as soap.		Cholesterin.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
14	0·831	100	0·157	18·89	0·613	73·77	0·044	5·29	0·017	2·04
15	0·539	100	0·419	77·73	0·005	0·93	0·017	3·15	0·097	18·00
16	1·139	100	0·423	37·14	0·569	49·96	0·044	3·86	0·102	8·96
17	1·084	100	0·377	34·77	0·595	54·89	0·066	6·09	0·046	4·24
Average	0·898	100	0·344	42·13	0·446	44·89	0·043	4·60	0·066	8·31
27	2·728	100	0·310	11·36	1·357	49·74	1·025	37·57	0·036	1·32
28	1·933	100	0·266	13·76	1·291	66·79	0·293	15·16	0·080	4·14
29	2·313	100	0·365	15·78	1·430	61·82	0·454	19·63	0·068	2·94
Average	2·325	100	0·314	13·63	1·359	59·45	0·591	24·12	0·061	2·80

On this point, in normal dog No. 2, the analysis was carried out during two periods, as shown in Table XV. In the first period the dog received 15·20 grams of fat daily, and four days were separately analysed; while during the second period the dog received 65·19 grams of fat, and three days were separately analysed.

We see that the quantity of free fatty acids, as compared to neutral fat, is somewhat greater on the diet poor in fat, while on the diet rich in fat it is very markedly so, being no less than 0·314 gram of neutral fat and 1·359 grams of free fatty acids. The soap is also very markedly increased, namely, from 0·043 to 0·591 gram by increasing the quantity in the fat diet; the cholesterin, however, remains the same, being 0·066 and 0·061 gram. The percentage, taking the total ether extract as 100, on the diet poor in fat, is 40·13 per cent. of fat as neutral fat, 44·89 per cent. as free fat acids, and 4·60 per cent. as fat acids in form of soaps; while, when the diet is rich in fat, and the fæces, in spite of the increased absorption, contained more than double the quantity of ether extract, these contained only 13·63 per cent. as neutral fat, 59·45 per cent. as free fat acids, and 24·12 per cent. as soaps. The percentage of cholesterin naturally differs owing to the increased quantity of total ether extract.

Table XVI. In dog 1, on a diet rich in fat, containing no less than 62 grams of fat, the total result is very much the same as that obtained in the previous table, the percentage of fat acids being in excess of neutral fat; the cholesterin, however, in this case, was somewhat higher than in the former dog.

Table XVII. When the partial removal of the large intestine was carried out during three days' analysis on a diet containing 51·73 grams of fat daily, the same holds good, the quantity of cholesterin, however, corresponding with Table XVI being no less than 0·145 gram.

Table XVIII. In the case of dog 4, in which the large intestine has been entirely removed, on a diet comparatively poor in fat—29·7 grams—the quantity of free fatty acids is very much in excess of the neutral fat, the soaps being also slightly in excess of the fat acids; the cholesterin, on the other hand, is very markedly decreased, the average being only 0·025 gram per diem.

Table XIX. Again, in dog 5, on a diet containing 41·6 grams of fat, the animal had slight diarrhœa; throughout the three days experimented on the quantity of fat acids was again in excess of the neutral fats, and the fat acids as soaps were not increased. The cholesterin, as in the former dog, was on the whole diminished, being only 0·069 gram.

In Table XX the average results of the two normal dogs are compared with that of partial and complete removal of the large intestine, and it is seen that as far as the fat is concerned the composition of the ether extract in the fæces remains practically the same, whether the large intestine is present or absent, the fat acids being in both greatly in excess

Table XVI.—Composition of Ether Extract of Fæces. Normal Dog 1, on a Diet rich in Fat, containing 62·04 grams of Fat daily.

Day.	Total ether extract.		Neutral fat.		Free fat acids.		Fat acids as soaps.		Cholesterin.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
22	0·876	100	0·082	9·36	0·549	62·67	0·113	12·90	0·131	14·95
23	1·583	100	0·180	11·37	1·115	70·43	0·126	7·96		
24	0·951	100	..	..	..	..	0·180	18·93		
25	1·644	100	0·154	9·37	1·041	62·32	0·281	17·09	0·168	10·22
Average	1·264	100	0·139	10·03	0·902	65·47	0·233	14·22	0·154	11·80

Table XVII.—Composition of Ether Extract of Fæces. Partial Removal of Large Intestine on a Diet of 51·73 grams of Fat.

Day.	Ether extract.		Neutral fat.		Free fat acids.		Fat acid as soap.		Cholesterin.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
36	0·762	100	0·033	4·33	0·443	58·14	0·086	11·29	0·199	26·12
37	—	—	—	—	—	—	—	—	—	—
38	0·553	100	0·088	15·91	0·316	57·14	0·071	12·84	0·110	19·89
39	1·602	100	0·313	19·54	0·784	48·94	0·378	23·59	0·126	7·87
Average of three days	0·972	100	0·145	13·16	0·514	54·74	0·178	15·91	0·145	17·96

Table XVIII.—Composition of Ether Extract of Fæces. Complete Removal of the Large Intestine, the Diet containing 29·7 grams of Fat daily.

Day.	Ether extract.		Neutral fat.		Free fat acids.		Fat acids as soaps.		Cholesterin.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
29	1·248	100	0·169	13·54	0·628	50·32	0·452	36·22		
30	0·660	100	0·082	12·43	0·427	64·70	0·123	18·64	0·027	4·09
31	0·710	100	0·158	22·25	0·452	63·66	0·074	10·42	0·026	3·66
32	0·585	100	0·085	14·53	0·408	69·74	0·070	11·97	0·022	3·76
Average	0·801	100	0·124	15·69	0·479	63·11	0·180	19·31	0·025	3·84

Table XIX.—Composition of the Ether Extract of Fæces. Complete Removal of the Large Intestine, the Diet containing 41·6 grams of Fat.

Day.	Total fat.		Neutral fat.		Free fat acids.		Fat acids as soaps.		Cholesterin.	
	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
23	0·936	100	0·144	15·38	0·443	47·33	0·281	30·02	0·068	7·27
24	0·701	100	0·136	19·40	0·464	66·19	0·024	3·42	0·076	10·84
25	0·507	100	0·070	13·81	0·333	65·68	0·042	8·28	0·062	12·23
Average	0·715	100	0·116	16·20	0·413	59·73	0·166	13·91	0·069	10·11

Table XX.—The Effect of Removal of the Large Intestine on the breaking up of Fat in the Alimentary Canal. Composition of Fat of Fæces.

No.	Duration of observation.	Total ether extract.		Neutral fat.		Free fat acids.		Fat acids as soaps.		Cholesterin.	
		Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.	Total.	Per cent.
	days.										
					Average of Two Normal Dogs.						
1	4	1·264	100	0·139	10·03	0·902	65·47	0·233	14·22	0·154	11·80
2	3	2·325	100	0·314	13·63	1·359	59·45	0·591	24·12	0·061	2·89
					Average of Partial Removal of Large Intestine.						
3	3	0·972	100	0·145	13·16	0·514	54·74	0·178	15·91	0·145	17·96
					Average of Two Dogs after Complete Removal of the Large Intestine.						
4	4	0·801	100	0·124	15·69	0·479	62·11	0·180	19·31	0·025	3·84
5	3	0·715	100	0·116	16·20	0·413	59·73	0·116	13·91	0·069	10·11

of the neutral fat and the fat acids as soaps. In some the quantity of fat acids combined as soaps is much greater than the neutral fat, and in others they are very much alike; but at any rate the large intestine appears to have no influence whatever in altering the composition of the fats in the fæces. On the other hand there is a difference in the quantity of cholesterin present.

It is seen that in the second normal dog the quantity of cholesterin differs considerably from that seen in the first, and that results seen in the partial removal of the large intestine correspond with the normal dogs. On the other hand, in the two dogs in which the large intestine was completely removed, the cholesterin found was small in quantity; and if the averages are taken it is seen that the removal of the large intestine tends to cause a decrease in the quantity of cholesterin daily eliminated in the fæces.

It has already been shown by Jankau* that large quantities of cholesterin given by the mouth are absorbed, and therefore it is not at all surprising if the quantities of cholesterin which are daily eliminated in the bile, &c., are to a certain extent absorbed in the small intestine, that the absence of the large intestine should have no effect in increasing the quantity found in the fæces. At the same time, the fact that the actual quantity of cholesterin found in the fæces appears to be smaller in dogs without a large intestine, would appear to be explainable by the fact that the secretion of the large intestine itself contains cholesterin. Further, it is conceivable that it is not so readily absorbed by the large intestine, hence the quantity of cholesterin normally present is larger than that found when the large intestine is absent.

Before leaving the subject of the fæces, it is of interest to note their alteration as regards colouring matter after the removal of the large intestine.

The Action of the Removal of the Large Intestine on the Urobilin Formation in the Fæces.

In a paper already published I showed† how it seemed probable that the presence of urobilin in the urine was due to the conversion of the bile pigments during their passage along the intestines.

Schmidt‡ showed that when a concentrated solution of perchloride of mercury is applied to wet or dry fæces containing urobilin, in the space of a few minutes a bright rose-red colour is developed. The rose-coloured extract, when separated and examined with the spectroscope, shows the urobilin band between F and *b*. This test is all the

* Jankau, 'Archiv f. Exp. Path. u. Pharm.,' vol. 29, p. 237, 1892.

† Vaughan Harley, 'Brit. Med. Journ.,' Oct. 3rd, 1896.

‡ Schmidt, 'Verhandlungen d. Congress f. Universale Medicin,' p. 320, 1895.

more valuable since in the presence of bile it gives a bright green colour, in consequence of the conversion of bilirubin into biliverdin by the perchloride of mercury.

Since this method has been introduced it has become possible to recognise very small quantities of urobilin in the fæces.

Schmidt, examining by this method the different parts of the intestine and intestinal walls, showed that the urobilin reaction yielded results proving that in different parts of the intestine urobilin was present in varying degree, and also varied in different cases. The staining of the intestinal walls by this method, he considered, indicated the parts of the intestine which took part in the absorption of urobilin. My own experiments on dogs and monkeys, in which the post mortem examination was made immediately after death, showed no such staining of the walls, and therefore I consider it was probably due to a post mortem diffusion.

The test, however, is valuable for the determination of urobilin in the contents of the bowel, and this we will now consider.

I noted in various animals that as a rule no trace of urobilin could be found in the contents of the intestine above the ileo-cæcal valve. In some few dogs there was a trace of urobilin in the contents just above the cæcum, but in the majority of normal dogs recognition of this substance was only possible after the ileo-cæcal valve was passed.

Of the dogs in which the large intestine had been removed, dog 5 was killed by chloroform and the contents examined. In this dog the post mortem showed the small intestine to have been artificially joined to the rectum 6 cm. from the anus; and 78 cm. from the anus the green colour was first noticed by the perchloride of mercury reaction, and then, 35 cm. from the anus, began to show the urobilin reaction, which extended as far as the anus.

In dog 4 only 4 cm. of the rectum was found remaining at the post mortem, and this dog only showed a very faint urobilin reaction in the contents of this latter 4 cm. That is to say, throughout the entire small intestine of this dog no reaction of urobilin could be obtained.

These post mortem results were borne out to a certain extent by observations during life. It was found in most of the dogs, in which the large intestine had been removed, that immediately after the operation the motions were bile-stained, and gave the green colour with perchloride of mercury, and, only very faintly or not at all, the pink urobilin reaction. Later on the urobilin became increased, and the bilirubin apparently decreased.

In dog 5, throughout the time metabolism experiments were carried on, there was always more marked urobilin than in other dogs observed after the removal of the large intestine.

The Influence of Diet on the Total Alkaline and Aromatic Sulphates in Normal Dogs and in those in which the Large Intestine has been in part or completely Removed.

Having discussed the fæces, we now come to consider the sulphates in the urine. As we all know, the sulphur taken in the diet is principally excreted in the form of sulphates, either combined with alkalis or with aromatic substances, although some 14 to 25 per cent. of the total sulphur in the urine is excreted as neutral sulphides.*

In this paper the sulphides were not determined. The sulphates contained in the urine are principally derived from the proteids in the diet, as only very small quantities are taken in the form of salts, and, in consequence, the ratio of sulphuric acid to nitrogen excreted in the urine remains very parallel—5 : 1. Hence it will be seen in the following tables that the proteid-sparing action of the increase of fat causes not only a decrease in the nitrogen in the urine in normal dogs but also a decrease in the quantity of the sulphates. The sulphur of the proteids in fact had been retained in the organism for building up the proteid of the body itself, in the same way as the nitrogen had been.

The aromatic sulphates were also investigated after removal of the large intestine in order to see if the intestinal putrefaction was in any way influenced by the removal of the large intestine; for the experiments of Salkowski,† Baumann,‡ &c., have shown that in all probability the phenol, indol, &c., which, when absorbed into the blood, go to form the aromatic sulphates, are only formed in the large intestine.

Baumann and Ewald§ have described cases of intestinal fistula; during the time in which the fæces were excreted through the fistula the quantity of aromatic sulphates was very much diminished in the urine.

Table XXI. In normal dogs the analyses of the sulphates were carried out during three periods in which the dog received progressively an increase of fat in his diet.

We have already seen that this increase of fat caused a decrease in the quantity of urine and in the quantity of nitrogen daily eliminated. Accompanying this, we find in the above table there is also a decrease in the quantity of the alkaline sulphates progressively with the increase of fat. On the other hand, the aromatic sulphates are not influenced by the increase of fat to 32·04 grams per diem; but on increasing the fat to 62·04 grams there is an apparent decrease in the aromatic sulphates.

* v. Noorden, 'Lehrb. d. Path. Stoff.,' p. 283.
† Salkowski, 'Zeit. f. Phys. Chemie,' vol. 10, p. 266, 1886.
‡ Baumann, *ibid.*, vol. 10, p. 126, 1886.
§ Ewald, 'Arch. f. Path. Anat.,' vol. 75, p. 409.

Table XXI.—Normal Dog 1. The Influence of an Increasing Quantity of Fat in a Fixed Proteid and Carbohydrate Diet on the Sulphates in the Urine.

Day.	Weight.	Diet.		Urine.			Sulphates.		
		N.	Fat.	Quantity.	N.	Total.	Alkaline, A.	Aromatic, B.	A : B.
	kilos.	grams.	grams.	c.c.	grams.	grams.	grams.	grams.	
8	4·59	4·82	12·04	125	4·382	0·663	0·617	0·046	11 : 1
9	4·59	4·82	12·04	130	4·810	0·619	0·558	0·061	9 : 1
10	4·59	4·82	12·04	120	4·399	0·625	0·557	0·068	8 : 1
11	4·59	4·82	12·04	95	4·236	0·642	0·561	0·081	7 : 1
Average...	4·59	4·82	12·04	118	4·457	0·637	0·573	0·064	9 : 1
15	4·59	4·82	32·04	95	3·754	0·564	0·489	0·075	7 : 1
16	4·59	4·82	32·04	94	3·625	0·591	0·504	0·087	7 : 1
17	4·59	4·82	32·04	80	3·164	0·424	0·380	0·044	9 : 1
18	4·59	4·82	32·04	85	3·575	0·544	0·543	0·055	9 : 1
Average...	4·59	4·82	32·04	89	3·575	0·544	0·479	0·065	8 : 1
22	4·63	4·82	62·04	70	3·235	0·483	0·428	0·054	8 : 1
23	4·63	4·82	62·04	65	3·340	0·483	0·447	0·058	8 : 1
24	4·63	4·82	62·04	60	3·085	0·526	0·472	0·054	9 : 1
25	4·63	4·82	62·04	85	3·789	0·569	0·512	0·058	9 : 1
Average...	4·63	4·82	62·04	70	3·362	0·521	0·465	0·056	8·5 : 1

The decrease in the alkaline sulphates and no alteration in the quantity of aromatic sulphates during the second period causes the ratio A to B to fall from 9 : 1 to 8 : 1, that is to say, by discussing only these ratios, one would consider that the intestinal putrefaction had really been increased instead of decreased. However, on increasing the fat in period 3, the decrease in the aromatic sulphates was sufficient to counteract the decrease in total sulphates, so that the ratio was 8·5 : 1.

On turning to Table XXII, normal dog 2, we see the increase of fat in the food causes, as in the preceding dog, a decrease in the quantity of urine, and at the same time a decrease in the quantity of nitrogen excreted; there is also in this case a more marked decrease in the quantity of alkaline sulphates, but this is due to the greater decrease in the quantity of nitrogen. The aromatic sulphates, however, are slightly decreased, the normal ratios being 7 : 1, while the ratio on the increased fat diet is 6·6 : 1. We here have also, even in spite of a decrease of aromatic sulphates produced by increasing the fat in the diet (since the alkaline sulphates are more markedly decreased), a smaller ratio, which would lead us to believe that intestinal putrefaction is increased.

From these two dogs we see that the old idea that the ratio 8 or 10 : 1 should be considered as the normal ratio indicating intestinal putrefaction must be corrected, and that in future it is not sufficient to make out the ratio of the total day's urine, but it is essential to compare the quantities in a given space of time, for on a diet rich in fat the ratio may be very much diminished, say to 6 : 1, in spite of the aromatic sulphates being also diminished.

It would further appear that in a normal dog fat added to the diet, if anything, tends to decrease the amount of aromatic sulphates, so that the increase of fat does not cause an increase of intestinal putrefaction.

Table XXIII. We now come to discuss the dog in which the large intestine was in part previously removed. In this case we have the same decrease in water and nitrogen in the urine by an increase in the fat as in normal dogs, and also a decrease in the alkaline sulphates and aromatic sulphates. In fact, the results, as far as the sulphates are concerned, obtained in this dog, correspond exactly with those found in the two normal dogs, so that we can conclude the partial removal of the large intestine has no effect on the sulphates.

Table XXIV. In dog 4 the effect of the total removal of the large intestine was investigated twice on two diets. In the first the diet contained 9·71 grams of fat, and in the second 29·71 grams.

We see in this dog that increasing the fat causes, as in the normal dog, a decrease in water and nitrogen in the urine, and this is also accompanied by a decrease in the alkaline sulphates, but no alteration

Table XXII.—Normal Dog 2. The Influence of an Increasing Quantity of Fat in a Fixed Proteid and Carbohydrate Diet on the Sulphates of the Urine.

Day.	Weight.	Diet.		Urine.			Sulphates.		
		N.	Fat.	Quantity.	N.	Total.	Alkaline.	Aromatic.	A : B.
	kilos.	grams.	grams.	c.c.	grams.	grams.	grams.	grams.	
9	6·41	8·00	15·20	130	6·950	0·681			
10	6·41	8·00	15·20	130	..	0·772	0·678	0·094	7 : 1
11	6·41	8·00	15·20	100	5·972	0·625	0·560	0·065	8 : 1
12	6·41	8·00	15·20	115	5·460	0·569	0·500	0·069	7 : 1
Average ..	6·41	8·00	15·20	119	6·127	0·662	0·579	0·076	7 : 1
14	6·41	8·00	15·20	90	5·530	0·639	0·558	0·081	6 : 1
15	6·41	8·00	15·20	85	5·159	0·567	0·491	0·076	7 : 1
16	6·41	8·00	12·20	115	6·314	0·714	0·620	0·094	6 : 1
17	6·40	8·00	15·20	143	6·258	0·797	0·720	0·077	9 : 1
Average ..	6·41	8·00	15·20	108	5·815	0·679	0·597	0·082	7 : 1
21	6·47	8·00	65·19	93	4·190	0·502	0·437	0·066	7 : 1
22	6·52	8·00	65·19	50	3·115	0·335	0·286	0·049	6 : 1
23	6·63	8·00	65·19	80	4·270	0·498	0·413	0·085	5 : 1
Average...	6·59	8·00	65·19	74	3·858	0·445	0·377	0·066	6 : 1

Table XXIII.—Partial Removal of the Large Intestine. The Influence of an Increasing Quantity of Fat to a Fixed Proteid and Carbohydrate Diet on the Sulphates of the Urine.

Day.	Weight.	Diet.		Urine.			Sulphates.		
		N.	Fat.	Quantity.	N.	Total.	Alkaline, A.	Aromatic, B.	A : B.
	kilos.	grams.	grams.	c.c.	grams.	grams.	grams.	grams.	
12	6·18	6·05	11·73	210	5·930	0·861	0·716	0·085	8 : 1
13	6·18	6·05	11·73	200	5·601	0·749	0·685	0·064	10 : 1
14	6·18	6·05	11·73	180	5·873	0·792	0·719	0·073	9 : 1
15	6·18	6·05	11·73	135	5·333	0·715	0·641	0·074	9 : 1
16	6·18	6·05	11·73	135	5·244	0·734	0·663	0·061	10 : 1
Average...	6·18	6·05	11·73	172	5·596	0·768	0·685	0·072	9 : 1
19	6·19	6·05	36·73	160	5·491	0·736	0·713	0·083	8 : 1
20	6·20	6·05	36·73	216	5·251	0·853	0·766	0·087	8 : 1
21	6·26	6·05	36·73	150	4·188	0·561	0·499	0·061	8 : 1
22	6·26	6·05	36·73	150	5·032	0·697	0·618	0·079	8 : 1
Average...	6·23	6·05	36·72	169	4·991	0·727	0·649	0·077	8 : 1
30	6·68	6·05	51·73	120	4·307	0·710	0·632	0·077	8 : 1
31	6·75	6·05	51·73	112	4·763	0·794	0·738	0·056	13 : 1
32	6·75	6·05	51·73	130	4·971	0·612	0·540	0·072	7 : 1
33	6·75	6·05	51·73	100	..	0·609	0·549	0·060	9 : 1
Average...	6·74	6·05	51·73	112	(4·630)	0·681	0·615	0·069	9 : 1

Table XXIV.—Total Removal of Large Intestine. Dog. 4. The Influence of an Increasing Quantity of Fat in a Fixed Proteid and Carbohydrate Diet on the Sulphates in the Urine.

Day.	Weight.	Diet.		Urine.			Sulphates.		
		N.	Fat.	Quantity.	N.	Total.	Alkaline, A.	Aromatic, B.	A : B.
	kilos.	grams.	grams.	c.c.	grams.	grams.	grams.	grams.	
8	4·05	6·80	9·71	110	4·437	0·620	0·588	0·032	18 : 1
9	4·05	6·80	9·71	170	4·812	0 675	0·640	0·033	19 : 1
10	4·05	6·80	9·71	210	4·120	0·555	0·518	0·037	14 : 1
11	4·05	6·80	9·71	275	4·418	0·543			
Average	4·05	6·80	9·71	191	4·445	0·598	(0·582)	(0·034)	17 : 1
15	4·05	6·80	9·71	397	4·405	0·541	0·516	0·024	22 : 1
16	4·05	6·80	9·71	309	4·290	0·564	0·534	0·034	17 : 1
17	4·11	6·80	9·71	320	4·427	0·645	0·624	0·023	27 : 1
Average	4·08	6·80	9·71	341	4·374	0·584	0·558	0·027	22 : 1
22	4·17	6·80	29·71	121	3·010	0·392	0·568	0·024	15 : 1
23	4·17	6·80	29·71	200	3·282	0·469	0·439	0·030	14 : 1
24	4·17	6·80	29·71	240	3·344	0·437	0·401	0·036	11 : 1
25	4·17	6·80	29·71	265	3·337	0·447	0·411	0·035	12 : 1
Average	4·17	6·80	29·71	207	3·243	0·437	0·405	0·031	13 : 1
29	4·24	6·80	29·71	52	1·230	0·220	0·194	0·026	7 : 1
30	4·30	6·80	29·71	210	3·220	0·448	0·411	0·036	11 : 1
31	4·31	6·80	29·71	190	3·690	0·462	0 427	0·035	12 : 1
32	4·31	6·80	29·71	140	3·620	0·493	0·458	0·034	13 : 1
Average	4·29	6·80	29·71	198	2·965	0·406	0·372	0·033	11 : 1
Average of three last days	..	..	..	247	3·510	0·468	0·432	0·035	12 : 1

in the amount of aromatic sulphates. The total quantity of aromatic sulphates in this dog is very much decreased, being only from 0·026 to 0·035 gram as against 0·064 to 0·082 gram in the normal dogs. We therefore see that the absence of the large intestine in this case caused a very marked decrease in the amount of aromatic sulphates, and this decrease in the amount of aromatic sulphates was, doubtless, due to the decrease of intestinal putrefaction, and explains how it was that urobilin was found in such small quantities in the fæces.

As far as the ratio of alkaline to aromatic sulphates is concerned, in the two periods with the small quantity of fat the ratio is 17 : 1 and 22 : 1, while during the two periods with the large quantity of fat the ratio was 13 : 1 to 12 : 1.

We have here even more markedly than in the normal dog the error brought out by only noting the ratio, and not the absolute quantity, of aromatic sulphates, for with a ratio of 12 : 1, as compared to that of 22 : 1, we should think the aromatic sulphates were very markedly increased if we did not know that this alteration in the ratio was due, not to an increase of the aromatic sulphates and therefore increase in the intestinal putrefaction, but simply to the decrease of alkaline sulphates in consequence of the proteid-sparing action of the increased fat in the diet.

In Table XXV, dog 5, only two periods were investigated. Here we see that a very marked diminution in the quantity of nitrogen was produced by increasing the fat from 11·55 to 41·55 grams. Accompanying this is an equal diminution in the quantity of alkaline sulphates. The aromatic sulphates in this case also were decreased in amount by increasing the fat; in consequence of this, the ratio in this dog remains much the same.

In Table XXVI are placed together the averages obtained in the preceding dogs, and it is seen that they compare very well with one another.

As a general conclusion, one may say that in all cases the increase of fat causes a decrease in the quantity of sulphates, and at the same time tends to decrease the quantity of aromatic sulphates; that in the absence of the large intestine this still holds good, although the aromatic sulphates are extremely small in amount.

It is thus useless to consider the ratio of alkaline to aromatic sulphates as an indication of the amount of intestinal putrefaction, unless the diet is poor in fat.

It is also important to note that the amount of proteid itself given in the diet does not influence the amount of aromatic sulphates nearly as much as one would expect, for in dogs 1, 2, and 3, in spite of the proteid varying in quantity very considerably, the quantity of aromatic sulphates remained the same.

Table XXV.—Dog 5. Total Removal of the Large Intestine. The Influence of an Increasing Quantity of Fat in a Fixed Proteid and Carbohydrate Diet on the Sulphates in the Urine.

Day.	Weight.	Diet.		Urine.			Sulphates.		
		N.	Fat.	Quantity.	N.	Total.	Alkaline, A.	Aromatic, B.	A : B.
	kilos.	grams.	grams.	c.c.	grams.	grams.	grams.	grams.	
10	6·30	6·26	11·55	90	4·508	0·509	0·419	0·059	7 : 1
11	6·30	6·26	11·55	86	4·110	0·391	0·342	0·049	7 : 1
12	6·30	6·26	11·55	120	4·461	0·416	0·364	0·051	7 : 1
13	6·30	6·26	11·55	96	4·343	0·481			
14	6·30	6·26	11·55	75	4·459	0·422	0·374	0·048	8 : 1
Average...	6·30	6·26	11·55	93	4·376	0·414	0·382	0·052	7 : 1
23	6·63	6·26	41·55	96	2·422	0·215	0·183	0·032	6 : 1
24	6·62	6·26	41·55	85	2·408	0·234	0·203	0·031	7 : 1
25	6·53	6·26	41·55	82	2·748	0·246	0·216	0·029	7 : 1
Average...	6·59	6·26	41·55	88	2·256	0·232	0·201	0·031	6·6 : 1

Table XXVI.—The Averages of Normal Dogs as compared with Partial and Complete Removal of the Large Intestine, showing the Influence of Increasing Quantity of Fat in a Fixed Proteid and Carbohydrate Diet on the Sulphates in the Urine. Nos. 1 and 2, Normal Dogs. No. 3, Partial Removal of the Large Intestine. Nos. 4 and 5, Complete Removal of the Large Intestine.

No.	Duration of observation.	Diet.		Urine.			Sulphates.		
		N.	Fat.	Quantity.	N.	Total.	Alkaline, A.	Aromatic, B.	A : B ratio.
	days.	grams.	grams.	c.c.	grams.	grams.	grams.	grams.	
1 (*a*)	4	4·82	12·04	118	4·457	0·637	0·573	0·064	9 : 1
(*b*)	4	4·82	32·04	89	3·573	0·544	0·479	0·065	8 : 1
(*c*)	4	4·82	62·04	70	3·362	0·521	0·465	0·056	8·5 : 1
2 (*a*)	4	8·00	15·20	119	6·127	0·662	0·558	0·076	7 : 1
(*b*)	4	8·00	12·20	108	5·815	0·679	0·597	0·082	7 : 1
(*c*)	3	8·00	65·19	74	3·858	0·445	0·377	0·066	6 : 1
3 (*a*)	5	6·05	11·73	172	5·596	0·768	0·685	0·072	9 : 1
(*b*)	4	6·05	36·73	169	4·991	0·727	0·649	0·077	8 : 1
(*c*)	4	6·05	51·73	112	4·680	0·681	0·615	0·066	9 : 1
4 (*a*)	4	6·80	9·71	191	4·445	0·598	0·582	0·034	17 : 1
(*b*)	3	6·80	9·71	341	4·374	0·584	0·588	0·026	22 : 1
(*c*)	4	6·80	29·71	207	3·243	0·437	0·405	0·031	13 : 1
(*d*)	3	6·80	29·71	247	3·510	0·468	0·432	0·035	12 : 1
5 (*a*)	5	6·26	11·55	93	4·376	0·382	0·052	0·052	7 : 1
(*b*)	3	6·26	41·55	88	2·526	0·232	0·201	0·031	6·6 : 1

Summary.

The conclusions to be drawn from the above experiments can be briefly summarised, so that the general results will be more readily seen.

1. The large intestine itself excretes a substance which contains proteids, fat, and salts, thus resembling "Hermann's loop," but at the same time contains no colouring matter, and so differs from the contents of the small intestine.

2. Increasing the quantity of fat on a standard diet in normal animals leads to a decrease in the quantity of urine passed, together with a decrease in the amount of nitrogen eliminated in the urine, but tends to increase its specific gravity. The quantity of fæces is increased when the quantity of fat in the diet is increased, and this is accompanied with an increase in the nitrogen eliminated, and a more marked increase in the quantity of fat eliminated from the bowel.

In consequence of the increase in the nitrogen in the fæces, there is a decrease in the amount of nitrogen absorbed from the alimentary canal, but in spite of the increase in the quantity of fat in the fæces, the increased quantity in the diet leads to an increase in the amount absorbed. The animal's weight increases, and this is due in part to the increase of fat tissue by the additional fat in the diet, but mostly to the fresh fat acting as a sparer of proteid destruction in the organism. (Table III.)

3. That increasing the quantity of fat in a standard diet in an animal after partial removal of the large intestine yields similar results as regards the urine and general metabolism to those found in normal dogs, except that the increased quantity of fat in the diet does not appear to cause an increase in the amount of the fæces, or an increase in the nitrogen of the fæces, and only a slight increase of fat in the fæces.

The partial removal of the large intestine causes a diminution in the absorption of nitrogen from the alimentary canal, which is only slightly influenced by increasing the fat in the diet. The absorption of fat seems to be influenced in the same manner as in normal dogs by increasing the fat in the diet. (Table V.)

4. The increased quantity of fat in a standard diet in dogs, after total removal of the large intestine, causes a decrease in the quantity of urine, and nitrogen in the urine, with a tendency to an increase in specific gravity.

The quantity of fæces is increased by increasing the fat in the diet, but the quantity of nitrogen and fat in the fæces is uninfluenced by the larger amount of fat taken, so that these dogs do not correspond to what is found in normal dogs. (Table VIII.)

5. The influence of increasing quantities of fat in the diet on the quantity of water in the fæces.

In normal dogs it is found that the increase of fat in the diet causes a progressive increase in the total quantity of water eliminated in the fæces, while the percentage of water is decreased, the total quantity of the fæces increasing with the increase of fat in the diet.

In partial removal of the large intestine there is also an increase in the total quantity of water, as well as apparently an increase in the percentage of water.

In complete removal of the large intestine there is an increase in the total quantity of water eliminated in the fæces, with an increase in the percentage of water eliminated by the bowel, the fæces increasing in quantity with the augmentation in the quantity of fat in the diet.

It is thus seen that increase of fat causes an increased quantity of fæces in the normal dog, the increased quantity of fæces is accompanied by an increase of total water, but a decrease in the percentage of water eliminated in the fæces, while in the case of the removal of the large intestine, the increase in the quantity of fæces is accompanied both with an increase in the total quantity of water and the percentage of water. (Table XIV.)

6. The influence of the removal of the large intestine on the absorption from the alimentary canal.

It has been already seen that the dogs passed a larger quantity of fæces when the large intestine had been removed, and this is to a small extent brought out in partial removal of the large intestine. It is seen that the increase in quantity of fæces is principally due to the increase in quantity of water, the total quantity being nearly five times as much as in the case of the normal dogs. The quantity of nitrogen in the fæces is increased to nearly three times as much as in the normal dogs, while the quantity of fat remains unaltered, and in those cases which were examined the fæces contained no carbohydrates.

It is therefore seen that as far as the absorption from the alimentary canal is concerned :—

(*a*) The carbohydrates are absorbed equally well with and without the presence of the large intestine.

(*b*) The fats are also absorbed equally well. The normal dogs show a percentage of absorption from 94 to 98, according to the amount of fat given. This apparently better absorption occurs with the increase of fat in the diet.

In partial removal of the large intestine the percentage is roughly 96, while when the entire large intestine is removed, from 92 to 98 per cent. of the fat given is absorbed, so that the dogs with and without the large intestine appear to absorb fat equally well.

(*c*) The proteids, as indicated by the nitrogen in the fæces, are, however, very markedly influenced. In normal dogs 93 to 98 per cent.

of the nitrogen given in the diet was absorbed, the quantity diminishing with the increased quantity of fat.

In partial removal of the large intestine from 89 to 90 per cent. of the nitrogen was absorbed, the quantity not decreasing as in the normal dogs with the increase of the fat in the diet. When the entire large intestine is removed only 84 per cent. of the nitrogen given in the diet was absorbed. The quantity absorbed is uninfluenced by the increase of fat in the diet.*

One may therefore conclude that 10 per cent. at least of the nitrogen in the diet is absorbed by the large intestine, and in all probability a very much larger quantity, as we have seen the large intestine itself excretes a nitrogen-containing substance. (Tables III, V, VIII.)

7. The effects of removal of the large intestine on the breaking up of fat in the alimentary canal.

In comparing the separate analyses of the fat contained in the fæces, it is found the fat acids, neutral fat, and fat acids present as soaps remain practically the same in dogs with and without the large intestine. It would, however, appear that the quantity of cholesterin tends to decrease in the fæces in the absence of the large intestine. (Table XX.)

8. The action of the removal of the large intestine on urobilin formation.

In normal dogs the fæces were found to contain no bile, but large quantities of urobilin, while when the large intestine was removed this was not always the case, as in some, especially soon after the operation, large quantities of bile pigment would be recognised in the fæces with little or no urobilin.

On examining the walls of the intestine it was found that the urobilin reaction in normal dogs as a rule could only be obtained beyond the ileo-cæcal valve. In two dogs in which the large intestine was removed only a slight urobilin reaction was discovered in the ilium.

9. The influence of fat on the total alkaline and aromatic sulphates.

In normal dogs increasing the quantity of fat in the diet causes, with the decrease in the quantity of nitrogen in the urine, a corresponding diminution in the quantity of total sulphates. This steady decrease in the total sulphates is not due to a diminution in the quantity of the aromatic sulphates, but of the alkaline sulphates, since the aromatic sulphates are only very slightly decreased.

In consequence of this decrease in the alkaline sulphates the ratio of A : B is decreased, so that if one only referred to the ratio one would be led to believe that there was an increase in the intestinal putrefaction, while in reality there is no increase but rather a decrease, as indicated by the slight diminution in the quantity of aromatic sulphates. (Table XX. Dogs 1 and 2.)

* Experiment 5 (*b*) is admitted for the reasons already given.

10. The influence of removal of the large intestine on the total alkaline and aromatic sulphates.

The total sulphates are influenced in the same manner in the dogs without the large intestine as in normal animals by increasing the fat in the diet. The alkaline sulphates decrease with the diminution in the quantity of nitrogen eliminated in the urine. This diminution is due to the decrease in the alkaline sulphates, the same as in the normal dogs.

The increased quantity of fat in the diet has no influence apparently on the quantity of aromatic sulphates eliminated in the urine. The removal of the large intestine tends markedly to diminish the quantity of aromatic sulphates daily eliminated, the quantity eliminated being less than half the quantity found in a normal dog on the same diet; so that the removal of the large intestine evidently causes a marked diminution in the intestinal putrefaction, or rather has removed the principal seat for intestinal putrefaction. (Table XXVI. Dogs 4 and 5.)

February 2, 1899.

The LORD LISTER, F.R.C.S., D.C.L., in the Chair.

A List of the Presents received was laid on the table, and thanks ordered for them.

The following Papers were read:—

I. "Sets of Operations in Relation to Groups of Finite Order." By A. N. WHITEHEAD, M.A. Communicated by Professor A. R. FORSYTH, F.R.S.

II. "Note on the Enhanced Lines in the Spectrum of α Cygni." By Sir NORMAN LOCKYER, K.C.B., F.R.S.

III. "On the Effects of Strain on the Thermo-electric Qualities of Metals." By MAGNUS MACLEAN, M.A., D.Sc. Communicated by LORD KELVIN, F.R.S.

IV. "The Constitution of the Electric Spark." By ARTHUR SCHUSTER, F.R.S., and G. HEMSALECH.